FOREST RESEARCH IN INDIA,

1932-33

PART I.—THE FOREST RESEARCH INSTITUTE.

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1933

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CONTENTS.

FOREST RESEARCH IN INDIA, 1932-33.

PART I.—THE FOREST RESEARCH INSTITUTE.

CHAPTER I.—GENERAL REVIEW.

The immediate value of investigations has received special attention during the year. Not only was this necessary in view of the restriction of the programme imposed by economy, but without close consideration of immediate requirements there is fear of divorcing research, for which there is such vast scope, from practical forestry. Every effort has been made to ascertain and to take up the problems of most importance to the forest departments in the provinces, and problems of growing timber and other produce and of utilising what is available, have been selected with this object in view. A detailed programme of work in each of the branches for the three years 1933-36 was also drawn up at the Institute and sent to the provinces for suggestions. This programme, as finally modified, and a short descriptive guide to the Institute have been issued since the close of period under review.

In the Silviculture Branch, both Statistical and Experimental Sections record effective action on several important items of their programmes. A feature of the year is the close co-operation of the provinces and the Research Institute on several lines of investigation, such as the relative value of teak seed from different parts of its range for use in given localities, the study of *sal*(*shorea robusta*)regeneration and management problems over the whole geographical range of the species, the initiation of experiments with modern technique for the best management of bamboo, problems connected with irrigated plantations in canal colonies, and the collection of routine and special data for the compilation of multiple yield tables for deodar. The completion of these deodar tables with separate data for four grades of thinning, provisional as they inevitably are from the nature of the data, marks an important step forward as they are the first of their kind, and provide a fitting conclusion to the valuable work done at the Research Institute by the Statistical Assistant, Mr. Mahendru, whose period of deputation has now ended. Yield tables for *banj* oak (*Quercus incana*), a species which does not lay down annual rings in its timber enabling age to be determined, were also virtually completed before he left, and will, it is believed, be the first published solution of a

problem of this kind. Useful progress was made in finding practical means of measuring the volume of standing trees with sufficient accuracy for research work, a problem which is at present receiving much attention in many countries. Tables giving average volumes of trees of given dimensions were prepared for three leading matchwood species for which data were required. Experimental work continued on the existing lines; several investigations have reached a stage at which definite conclusions should be obtainable, but for various reasons. it has not been possible to complete the compilation and checking work. In addition to the teak seed origin experiment referred to, similar tests have been made with several other trees and some of them are giving positive results, though it is necessary to wait some years before it will be safe to draw conclusions and before data will be available on all the necessary points. Experiments on the effect of burning *sal* (*Shorea robusta*) plantations, and on the storage of root and shoot cuttings before planting have, among others, given interesting results. All available information on two subjects of far reaching importance was collected and published as a basis for current procedure and further research. These were the question of the advisability of raising teak in pure plantations, and the importance of the origin of seed used in plantations. With a view to preparing a similar survey of *sal* regeneration and management, an extensive tour in six provinces was organised to enable the Silviculturist to meet and discuss problems in representative forests with officers with special experience: the resultant report will, it is hoped, satisfactorily meet a much felt need.

Nearly eight hundred specimens were identified by the Forest Botanist during the year, and the description of grasses to complete Duthie's Flora of the Upper Gangetic Plain was continued by Mr. R. N. Parker. 3.376 sheets were added to the herbarium and numerous additions made to the arboretum and fruticetum. A simple illustrated handbook of 40 common Indian trees will issue shortly to meet the requirements of educational institutions and the general public. In the Mycological Section the root disease of *shisham* (*Dalbergia sissoo*), the dying back of *Gmelina arborea* and the damping off of seedlings in nurseries were studied. Results of inoculation with *Peridermium himalayense* and an outline of the control measures suggested will be published shortly.

Considerable progress was made in the identification of the insect fauna of sandal; eleven out of the thirty-five specialists who are collaborating with the Entomological Branch of the Institute furnished reports. Much ground has been covered in the search for a vector of spike disease and a large number of transmission experiments have been conducted; symptoms resembling spike have been produced by four species of insects. and since the close of the year a more definite indication has been reported. The problem of preventing borer attack on bamboos by felling at suitable seasons, and by treatment with suitable antiseptics,

has been solved. The myth about the effect of the moon's phases on liability to damage has been scientifically disproved. The safest period to fell bamboos at Dehra Dun is at the end of the hot weather and in the first month of the monsoon, and the next best period is from the end of the monsoon to the beginning of the cold weather. The study of natural factors controlling teak defoliators has progressed far enough to establish the principles of biological control in plantations, and the control of secondary borers of *sal* (*Shorea robusta*), which become important where *Hoplocerambyx* is kept in check, has been investigated. Some 36,000 insects, mainly timber borers, have been bred in the insectary and hundreds of specimens, including 300 new species, have been added to the collection. Twenty-five publications were issued or sent to the press.

The economic side of Indian forestry marks a great advance with the publication of the manual *Commercial Timbers of India* by Sir Ralph Pearson, formerly Forest Economist at the Forest Research Institute, and Professor H. P. Brown of Syracuse University, U. S. A., who for some time worked at the Forest Research Institute. This manual deals with the anatomical characteristics, identification, distribution, strength, seasoning, durability, working qualities, uses, and supplies of 320 timbers selected from among some 2,500 varieties that grow in the forests of India.

In the Economic Branch of the Institute economy was effected by restricting large scale experiments so far as possible. Four hundred samples of wood were identified in the Wood Technology Section, and a key to the important timbers of the Punjab is nearly complete. Valuable additions were made to the authentic collections of wood specimens and of photomicrographs.

A large number of mechanical tests and shrinkage and physical determinations were made in the Timber Testing Section. An important addition to the programme of work was the testing of glue joints made by the ground engineers of the flying clubs in India; as a result of these tests a substantial improvement has been made and repair work is more dependable and flying safer. An interim report on tests of structural timber by Mr. L. N. Seaman was issued in June 1933 and gives safe working stresses for 129 Indian timbers. Mr. V. D. Limaye has prepared a third interim report recording the mechanical and physical properties of 140 Indian timbers.

In the Seasoning Section Dr. Kapur has evolved a process of kiln seasoning which is quicker, less costly and leads to less degrade than the process hitherto employed; two firms are being assisted with the installation of kilns. The air seasoning of railway sleepers in the Punjab was investigated and a report issued. In the Wood Preservation Section

laboratory tests of the arsenic preservative "Falkamesam" have given satisfactory results, and it is hoped that the claims made for it will be substantiated. Mr. Kamesam is also devoting attention to the fixation of copper in wood.

The Wood Workshop Section tried a number of indigenous timbers for a variety of purposes, apart from supplying timber throughout the Institute. Birch (*Betula alnoides*) from Bengal was found to have good qualities, and plywood was made from several other timbers. The panelling of figured laurel (*Terminalia tomentosa*) in the board room of the Institute is an exceptionally fine piece of work.

In the Minor Forest Products Section the "F. R. I." portable charcoal kiln worked satisfactorily, and good charcoal briquettes were made with *Bauhinia retusa* gum. The Paper Pulp Section was able to establish that bamboos (*Dendrocalamus strictus*) that have flowered and died yield a higher percentage of cellulose and paper than green culms, though rather more drastic digestion is needed. Satisfactory packing and wrapping paper was made from bagasse (crushed sugar cane), and small scale tests indicate certain further bamboos as suitable for the manufacture of pulp and paper. Laboratory results suggest a possibility of making artificial silk from *Melocanna bambusoides*, and pulp from *Eucalyptus globulus* appears suitable for use in admixture with long fibred pulp. Advice was given on a number of pulp and paper problems by Mr. Bhargava who was in charge of this section of the Institute.

The Chemical Branch records the results of the study of certain drugs, oils and fats. Contrary to expectations it has been found possible to grow *Artemisia maritima* with a satisfactory santonin content at the Institute, and it has been proved that storage of the seed of *Strychnos nux-vomica* does not involve any loss of strychnine. The Indian species *Derris uliginosa* was under examination as a possible source of rotenone, and the seed of *Actinodaphne hookeri* has been found to be an excellent source of lauric acid. Dr. Sri Krishna records that chemical examination of seasoned teak wood yielded neither an essential oil nor a fatty oil ; its oily nature is ascribed to the soft resinous substance it contains.

Mr. A. D. Blascheck, Inspector General of Forests to the Government of India and President of the Forest Research Institute, records his appreciation of work done by his staff. In spite of drastic economy much valuable research was in progress at the Institute, and a number of investigations yielded important results which can be applied at once. The staff of the Institute was reduced from 35 to 29 officers and the expenditure by nearly 30 per cent as compared with the average of the three previous years. Detailed reports of work in the several branches, lists of publications, and statements of staff and expenditure are given in the chapters and appendices that follow.

CHAPTER II.—SILVICULTURE BRANCH.

I.—EXPERIMENTAL SILVICULTURE.

(i) General.

No publication dealing primarily with experimental results obtained at Dehra Dun was published during the year, though such results contributed to a varying extent to the two papers referred to under *Records* below. Several of the investigations, however, are completed or sufficiently advanced to permit of useful deductions being drawn, and pressure of other work is the reason for their not having been written up.

Routine scrutiny of the copies of experimental plot records received from the provinces has been continued and suggestions made as required. There are at present 469 experimental plot files distributed among the provinces as follows:—Punjab 20, United Provinces 62, Bengal 83, Assam 10, Bihar and Orissa 75, Central Provinces 45, Madras 82, and Burma 88. Some of the plots dealing with *sal* regeneration in all these provinces except the first were visited by the Silviculturist during the year.

(ii) Natural regeneration.

The annual testing of *Anogeissus latifolia* seed from marked trees was carried out (Expt. 44). The year was an unfavourable one. During the past 5 years the average germinative capacity per 10,000 seeds has been 10, 12, 43, 24 and 14 respectively, the average seed crop per tree having been 5, 21, 23, 4 and 1 lb.

Seed crops (Expt. 10) of individual marked trees illustrated the general poor yields of the year, none of the *Shorea robusta* or *Terminalia tomentosa* under observation yielding any seed, and the *Pinus longifolia* but very little.

(iii) Investigations on seeds.

(*a*) *Seed weighments and germination tests.*—During the year 145 weighments were made including 8 species for which no previous records were available.

Effect of size of seed on germination and growth of seedlings (Expt. 57) was investigated for *Terminalia tomentosa* and teak, the seed being graded into five sizes for *Terminalia* and three for teak. The results for *Terminalia* appear to indicate both in plant per cent and average height an optimum at a point short of the maximum size, seed over 1·8″ length in 1932 and over 1·6″ in 1931 showing a falling off. Another test will be made.

For teak, the bigger the seed the better the results as shewn in the following statement, but the differences are small owing to very late germination.

Diameter class inches.	·4 to ·45.	·45 to ·5.	·5 to ·6.
Plant per cent	39	37	49
Average height at the end of first season, inches.	3·4±0·29	4·2±0·43	4·4±0·47

(*b*) *Seed storage* (Expt. 12).—Five species were added to the list under investigation, *viz.*, (23) *Melia azedarach*, (24) *Bombax malabaricum*, (25) *Schleichera trijuga*, (26) *Garuga pinnata*, and (27) *Cinnamomum camphora*. The results to date are tabulated below :—

Species.	Initial germinative capacity per cent.	Germinative capacity after storage. Stored in sacks. Period of storage in years.					Stored in sealed tins. Period of storage in years.				
		1	2	3	4	5	1	2	3	4	5
Acacia catechu	(85·5)	..	..	..	..	..	85	73	53	1	0
	(46 0)	2	3	0	..	..	46	6	1	0	0
Albizzia lebbek	(23·5)	..	..	20	..	..	23	28	16	13	5
	(34·5)	34	26	..	35	..	25	27	4	5	..
Albizzia procera	(70 5)	..	..	..	..	..	79	69	80	56	43
	50 5	28	45	10	11	..	31	34	22	23	..
Bauhinia variegata	(100)	..	..	..	..	..	100	69	11	0	0
	95	3	0	0	..	..	73	56	0	0	..
Butea frondosa	83	0	0	..	..	..	3	0	0	..	..
	(70)	..	..	..	..	..	70	87	0	..	..
Buxus sempervirens	3 1	0	..	..	..	..	0	..	..	..	..
Cassia fistula	10	00	10	20	0	..	..	28	44	9	..
Cedrus deodara	71	0	..	..	..	..	0	..	..	..	..
Dalbergia sissoo	(79)	..	..	..	..	..	70	63	67	43	2
	91	..	..	..	..	..	41	92	84	0	..
Dendrocalamus strictus . . .	50 5	1	0	..	..	..	54	43	..	..	..
Holarrhena antidysenterica . .	83 5	53	4	0	0	..	68	..	20	4	..
Lagerstroemia flos-reginae . .	(25·5)	..	..	..	..	..	28	80	0	0	..
Pinus longifolia	79	86	71	6	0	..	95	90	83	65	..
	(93)	93	50	0.	..	..	..	..	..	..	..
Pongamia glabra	(11)	..	..	..	..	..	11	0	2	0	0
Sapium sebiferum	(33)	..	..	..	..	..	33	5	3	0	0
	11	..	..	..	..	..	11	0	0	..	..
Tectona grandis	30	32	3	..	..	..	47	27	..	..	..
Terminalia belerica	54	28	0	0	..	..	45	18	3	0	..
Terminalia tomentosa	30	0	29	0	0	..	20	38	25	0	..
Xylia dolabriformis	(93)	..	..	..	..	..	88	32	1	1	2
Zizyphus jujuba	(85)	..	..	..	..	..	85	90	80	24	28
	86	91	97	50	3	..	80	97	72	22	..

(c) *Aids to germination* (Expt. 13).—Last year's experiment with *Terminalia chebula* was repeated using 300 fruits in each test with the following results.

Treatment.	Germination per cent.		Plant per cent.		Average height at the end of first season.
	1931	1932	1931	1932	1932 Ins.
A. Pulp not removed, no treatment.	33·2	21·3	31·6	15·6	5·9
B. Pulp not removed, 1 minute in boiling water.	..	14·6	..	8·3	5·1
C. Pulp removed, 3 days in cold water.	26·5	22·6	25·3	15·6	5·5
D. Pulp removed, 7 days in sun .	21·6	16·6	21·1	9·3	5·1

It will be seen that the untreated control gave the best germination and plant per cent as was the case last year. A line sowing with the same lot of seed, unpulped, made at the break of the monsoon, gave very good results, better than any of these nursery bed tests.

(iv) Investigations on seedlings.

The morphological seedling studies as reproduced in Troup's *Silviculture of Indian Trees*, were completed for five species—*Afzelia bijuga*, *Dolichandrone falcata*, *Nyssa sessiliflora*, *Sterculia campanulata* and *S. urens*. Eight others were partly done, *viz.*, *Altingia excelsa*, *Buxus sempervirens*, *Diospyros ebenum*, *Litsaea polyantha*, *Machilus gamblei*, *Milusa velutina*, *Sterculia foetida* and *Tecoma undulata*. Some difficulty is experienced in getting seed to Dehra Dun in viable condition, and the winter cold or summer drought frequently kills or cripples the seedlings before the last required stage of development is reached.

The experiment (Expt.59) begun in 1930 on the effect of burning back *sal* line sowings was continued as the subject was one calling for statistical study to decide between conflicting reports from general observation. The resultant figures are tabulated below. There were two parallel experiments starting in 1930 and 1931 with lines 3 and 5 years old, 1½—2½ feet high. The 1930 set has been burnt three times running and for the first 2 seasons shewed no significant differences between the unburnt control, the cut back and burnt set, and the set burnt standing; in the third season, however, (1932) the unburnt control shewed a significant

lead of 20% in height (on about 5 ft.) over the other two sets. The 1931 set also shewed no significant differences in the first season, but in the second season in which the plants reached a height of about 5 ft., the set burnt standing shewed a significant lead over the other two which were very similar. The experiment is being continued to see whether these differences are maintained or increased and the effect of the burning without cutting back on the soundness and shape of the stems will be examined. The casualties from the burning have been quite unimportant.

Statement showing the results of burning back 3 and 5 year old sal *seedlings with and without previous cutting back*

Treatments.	Initial data.		At the end of 1st growing season.			At the end of 2nd season.			At the end of 3rd season.		
	Average height.	Percentage of established plants.	Average height.	Survival per cent.	Percentage of established plants.	Average height.	Survival per cent.	Percentage of established plants.	Average height.	Survival per cent.	Percentage of established plants.
	Ins.		Ins.			Ins.			Ins.		
1930 (3 year old *sal*)—											
A. Control (unburnt)	18·2±0·38	0	26·5±0·78	96	0	42·5±1·61	96	42	*65·8±2·20*	96	74
B. Uncut but burnt	19·8±0·39	0	28·1±0·68	92	0	42·2±1·07	92	12	54·4±1·17	87	29
C. Cut and burnt	17·9±0·39	0	27·6±0·86	90	0	40·4±1·24	90	15	54·1±1·26	90	37
1931 (5 year old *sal*)—											
A. Control (unburnt)	30·1±0·87	0	43·8±1·33	100	48	59·0±1·73	100	70	..	..	.
B. Uncut but burnt	28·5±0·65	0	44·1±1·27	99	40	*61·3±1·13*	97	48	..	..	.
C. Cut and burnt	*31·7±1·01*	0	45·8±1·43	100	40	58·1±1·61	83	60	..	..	..

NOTE.—Italicised figures are significantly greater than others of the same set.

(v) Investigations on trees and crops.

(*a*) *Seasonal course of height growth* (Expt. 2).—This study has been in progress for important species for several years now, perhaps long enough for correlation with meteorological fluctuations. Some preliminary compilation work has been done, but detailed analysis remains pending.

(*b*) *Phenological data* (Expt. 1).—The same remarks apply as for the foregoing investigation.

(*c*) *Inheritance of individual characters* (Expts. 7 and 67).—Seed of solid bamboo was received from Angul division and stock raised for further study. Seedlings were raised from seed from trees suspected of being hybrids between *Terminalia tomentosa* and *T. arjuna*; they showed a certain amount of variation and are being kept under observation.

(*d*) *Inheritance of climatic race characters* (Expt. 6).—Work was continued with all-India teak seed origin investigation, stock being raised for all the 11 origins under trial. Very marked differences are apparent in germination, appearance and early development, and this co-operative study will undoubtedly lead to useful results.

(*e*) *Inheritance of physiological race characters* (Expt. 6).—Small plantations of *Butea* and *Schleichera* forms reported to behave differently under lac culture were completed and extended.

(*f*) *Soil Quality Class indicators* (Expt. 49).—The quadrats in plantations of different species were continued and some new ones added to follow succession in societies of the more conspicuous soil covers.

(*g*) *Congestion in bamboo clumps* (Expt. 8).—The required set of plantations of different origins was completed and many of the clumps are really big enough to permit of experiments on the possible causes inducing congestion. Field observations were also collected in the Hoshiarpur and Lansdowne bamboo forests.

(*h*) *Effect of autumn irrigation on leaf fall of teak* (Expt. 65).—The conclusion reached last year was confirmed, that under Dehra Dun climatic conditions, abundance of soil moisture makes no difference to the date of the drying up and falling of the leaves.

(vi) Artificial Regeneration.

Weather conditions affecting results were as follows. The 1931 monsoon rainfall was low but well distributed, and the 1931-32 cold weather was completely rainless and consequently nearly free from frost. The hot weather was fairly normal though very dry. The 1932 monsoon broke on July 5th and was very strong and exceptionally well distributed providing conditions too moist for species more adapted to drier climate

or soil, so that damping off was prevalent. The 1932-33 cold weather was also marked by good rainfall, with some frost.

(*a*) *Line sowings* (Expt. 14) were tried with *Chloroxylon swietenia*, *Soymida febrifuga*. *Lannea grandis*, *Mallotus philippinensis*, *Eugenia operculata* and *Terminalia chebula*, both in the open and in shaded lines. All made a satisfactory start but the *Soymida* largely damped off later particularly in the shaded lines. *Carallia integerrima* and *Celtis tetranda* sown in 1931 mostly died during the cold weather, *Pterospermum acerifolium* and *Terminalia chebula* continuing to develop.

(*b*) *Rains entire transplanting in the open* (Expt. 18).—The following species were tried in 1932, the survival percentage at the end of the year being given in brackets. *Chloroxylon swietenia* (84%), *Lannea grandis* (90%), *Carallia integerrima* (83%), *Eugenia operculata* (98%), *Schleichera trijuga* (5%), *Pterospermum acerifolium* (91%), *Stereospermum suaveolens* (86%), *Mallotus philippinensis* (78%), and *Erythrina suberosa* (73%). Until the plants have got over a dry season no practical conclusions can be drawn.

The following results were obtained at the end of the second growing season with species tried in 1931, the figures giving initial and final survival per cent. *Bauhinia retusa* (76-39%), *Celtis tetranda* (44-16%), *Pinus longifolia* with naked roots (26-2%), and *Pterospermum acerifolium* (85-19%). The heavy casualties during the hot weather are in part ascribable to the exceptionally dry conditions.

(*c*) *Rains entire transplanting in cleared lines* (Expt. 19).—The following species were put out in 1932, the survival per cent at the end of the year being given in brackets. *Chloroxylon swietenia* (*nil*), *Lannea grandis* (59%), *Carallia integerrima* (76%), *Eugenia operculata* (96%), *Schleichera trijuga* (35%), *Pterospermum acerifolium* (99%), *Stereospermum suaveolens* (38·6%), *Mallotus philippinensis* (37·5%), *Erythrina suberosa* (29%). For the species tried in 1931, the following figures shew the fall in survival per cent during the second growing season. *Pterospermum acerifolium* (91-70%), *Celtis tetranda* (92-82%) and *Schleichera trijuga* (86-56%).

(*d*) *Winter transplanting in the open* (Expt. 20).—In February 1931 four species were put out and the survivals in December 1931 and 1932 were as shewn:—*Hymenodictyon excelsum* (89-80%), *Broussonetia papyrifera* (80-76%), *Schleichera trijuga* (12-12%), and *Cedrela toona* (5-5%) bearing out general experience that the first hot weather is the critical time. The following species were added in December 1932:—*Lannea grandis*, *Chloroxylon swietenia*, *Soymida febrifuga*, *Mallotus philippinensis*, *Litsaea polyantha* and *Eugenia jambolana*.

(*e*) *Winter stump planting in the open* (Expt. 23).—Only *Erythrina suberosa* was put out in February 1931; survivals fell from 73 to 56 per cent during the second year but the growth was exceptionally vigorous.

In February 1932, *Butea frondosa* and *Albizzia lebbek* stumps were planted, of which the latter failed largely but the *Butea* gave 75% survival in December 1932. The following species were added during December 1932 :—*Acacia arabica*, *Anthocephalus cadamba*, *Garuga pinnata*, *Erythrina suberosa*, *Bauhinia retusa*, and *Bauhinia variegata*.

(*f*) *Rains stump planting in the open* (Expt. 21).—The following 12 species were put out in July 1932, the survival per cent at the end of the year being given in brackets. *Pterospermum acerifolium* (93%), *Schleichera trijuga* (92%), *Phoebe lanceolata* (99%), *Aleurites fordii* (100%), *Bauhinia variegata* (89·1%), *Adina cordifolia* (85·8%), *Albizzia lebbek* (100%), *Celtis tetranda* (94·3%), *Acacia arabica* (89%), *Bauhinia retusa* (54%), *Cedrela toona* (100%) and *Pistacia integerrima* (2%).

Of the species put out in July 1931, the percentages shewn below have survived to the end of the second growing season.

Species.	1931 RAINS STUMP PLANTING IN THE OPEN.			
	Planted on	Survival per cent on 1st January 1932.	Survival per cent on 1st January 1933.	Remarks.
Adina sessilifolia . .	22nd July 1931.	100	54	The *Santalum* and *Xylia* mostly died during the cold weather, whilst for the other species, casualties chiefly occurred in the hot weather.
Albizzia lebbek . . .	9th July 1931.	100	100	
Broussonetia papyrifera .	8th July 1931.	100	92	
Butea frondosa . . .	8th July 1931.	98	90	
Cedrela toona . . .	7th July 1931.	100	98	
Lannea grandis . . .	6th July 1931.	100	89	
Phoebe lanceolata . .	14th July 1931.	100	10	
Santalum album . .	6th July 1931.	80	0	
Terminalia myriocarpa .	7th July 1931.	37	13	
Xylia xylocarpa . . .	7th July 1931.	98	0	

In this connection, the early use of teak stumps in Travancore as recorded in *The Indian Forester* should be mentioned as well as the fact that further evidence has accumulated that under ordinary conditions there is no risk of the starting of rot by using the method.

(*g*) *Rains stump planting in cleared lines* (Expt. 22).—The following eight species were put out in July 1932 :—

(1) *Pterospermum acerifolium*, (2) *Schleichera trijuga*, (3) *Phœbe lanceolata*, (4) *Alcurites fordii*, (5) *Bauhinia variegata*, (6) *Albizzia lebbek*, (7) *Cedrela toona*, (8) *Acacia arabica*. Survivals in December 1932 were 90-100% for all.

Of the 1931 trials, the following survival percentages were recorded at the beginning and end of the second year: *Broussonetia papyrifera* (86-70%), *Albizzia lebbek* (98-94%), *Butea frondosa* (100-98%), *Cedrela toona* (100-96%), and *Xylia xylocarpa* (44-20%).

(*h*) *Effect of injury to stumps* (Expt. 30).—Two forms of injury were tried in 1931 with *Gmelina arborea* and teak stumps, stripping about one-third of the bark, and bruising with a hammer. The stumps were planted in pits with decayed leaf mould in order to approximate more to forest soil, probably more favourable for bacterial or fungal attack than the experimental garden soil. No significant differences were found between the several treatments.

(*i*) *Storage of stumps before planting* (Expt. 31).—250 teak stumps made on 5th July 1932 were planted in comparable lots of 50 stumps after an exposure of 0, 5, 9, 15 and 21 days to sun, rain and wind, in a heap on a cement floor; it must be remembered that there was more or less rain on 15 of the 21 days. At the end of the growing season, the record was as follows, the 1931 experiment under less favourable conditions being also included :—

Length of storage.	Control.	3 days.	5 days.	9 days.	13 days	15 days.	21 days.
1932 experiment. Average height in inches	6·6±0·33	6·9±0·33	..	6·3±0·26	..	5·9±0·26	5·8±0·20
Survival percentage .	94	92	..	94	..	100	76
1931 Experiment. Average height in inches	12·8±0·67	11·8±0·70	10·1 ±0·64	10·3±0·60	9·4 ±0·71	..	..
Survival percentage .	98	98	94	92	84	..	..

Storage, as found in the experiments of previous years, makes surprisingly little difference in survival or development.

(*j*) *Early planting of stumps without irrigation* (Expt. 61).—This was repeated with teak, twelve sets being put out fortnightly, beginning from the end of January to the break of rains, just as had been done in the two previous years.

The results provide a general confirmation of those already obtained, that a quarter or a third of the stumps put out in January or February

survive and shew a better average height than the normal monsoon planting. This year, however, the height superiority is slight, and hot weather planting, including the set put out 20 days before the monsoon broke, suffered very high mortality. It is intended to repeat this experiment a few times more for correlation of results with weather conditions, but it is now sufficiently established that for the Dun climate, spring planting is too much of a gamble to be a practical proposition.

(*k*) *Number of plants per patch.*—Work is being continued on this point which should yield statistical evidence on the subject of root competition, but there is nothing to report at present. Experiments with *Pinus longifolia* and *Tectona grandis* were started and have progressed satisfactorily so far.

(*l*) *Branch cuttings* (Expt. 32).—Propagation by branch cuttings of *Melia azedarach*, *Ficus glomerata*, and *Ficus roxburghii*, planted on 24th June 1932 after a shower of rain, proved a failure, though the monsoon set in well 10 days later.

(*m*) *Twig cuttings* (Expt. 76).—The results obtained in a propagation bench constructed and maintained on lines which have proved very successful in England, were disappointing. The twigs were kept green and healthy for several weeks and the cut ends usually callussed over, but with occasional exceptions, only feeble root development was obtained, or no roots at all (*Quercus*, *Machilus*).

(*n*) *Comparison of nursery stock and natural seedlings* (Expt. 56).—*Eugenia jambolana* jungle transplants were compared with two sets of nursery transplants, one being dug up from the nursery bed at the same time as the jungle ones and one immediately before planting. At the end of the first growing season no significant difference was found between the three sets, either in height growth or survival per cent. In all cases the survival per cent was more than 90. This confirmed the 1931 results with this species.

(*o*) *Comparison of nursery and forest stumps* (Expt. 46).—It was reported last year that with *Dalbergia sissoo*, forest stumps gave ⅔rds the survival of the nursery stock, but the same height growth in their first growing season: the same relationships have persisted to the end of the second season.

(*p*) *Comparison of sowings, transplants, and stumps* (Expt. 53).—Four species were used, indicating a higher survival and better height growth with teak stumps, higher survival (100%) but poorer height growth with *Bauhinia variegata* stumps, and lower survival but better height growth with *Acacia catechu*, illustrating well the great variation to be expected with different species. Marked superiority was found in height growth from stumps and transplants of *Gmelina* over direct sowings. These results refer only to the end of the first growing season,

an important point as is shewn by the 1931 experiment with *Terminalia tomentosa*. In this, survivals at the end of 1931 were 96%, 92% and 90% for transplants, stumps and sowings respectively, but at the end of 1932 had become 74, 26 and 66 respectively; despite their casualties, however, the stumps retain their superiority of nearly 100% in average height. Experience with *Acacia catechu* is similar except that the sowings which were far behind in height after one season, have caught up to the transplants in the second, the stumps maintaining a 50% lead.

(*q*) *Soil working between lines* (Expt. 58).—Teak lines were found in a previous experiment to respond to an appreciable extent to soil working at the end of the rains. A repetition commenced at the end of 1931 has not given a similar result, the hoeing having been done on 5th December 1931 and 3rd October 1932, final measurements being taken in March 1933.

(*r*) *Araucaria cunninghamii plantation* (Expt. 68).—The small plantation started in June 1931 is doing well, having reached an average height of about 3 feet with only 2% casualties, but it was a good deal damaged by hail at the end of the year.

(vii) Nursery work.

In addition to raising stock of various species for use in the experimental garden and demonstration area, a few experiments on nursery practice were also carried out.

(*a*) *Manuring of nursery beds* (Expt. 16).—The relative value of farmyard, artificial farmyard and green manures were tested with teak (Travancore seed). The results of experiments made during the last six years were summarised and published in the May 1933 issue of *The Indian Forester*, with special regard to the utilisation of vegetable waste in the form of '*artificial farmyard manure*'. The method is decidedly a useful and economical one for permanent nurseries.

(*b*) *Nursery bed shades* (Expt. 14).—In 1931, 5 types of shades, *viz.*, batten 33% and 66% shade, bamboo chick, thatch and iron sheet, were tried using *sal* as it was known to do better with a certain amount of shade. Assessed on the best plant per running foot of drill lines the complete shades both gave better height and survival than the unshaded control and the partially shaded beds gave the same results as the total shaded. Both frost and insolation are in question. The batten and chick shades have the merit of convenience in handling but are more expensive than the thatch if this does not have to be purchased.

(*c*) *Weed control in nurseries* (Expt. 15).—Paper mulch was again compared with weeded beds for *Dalbergia latifolia*. The total dry

weight of weed growth was not very different but the prepared lines shewed a small but significant superiority in height. On the whole, the use of paper mulch has not proved worth while.

(viii) Miscellaneous.

(*a*) *Effect of Tephrosia candida on soil moisture* (Expt. 64).—The 1930 experiment was repeated in 1931 with teak (Coorg) stump planted 6′×6′ in April 1929. *Tephrosia* was sown in April 1931 on worked lines 1½ feet broad between the teak lines. Soil samples were taken on 30th October and 17th November 1931, and again on 21st April, 18th and 29th June, 3rd and 18th October, and 2nd November 1932. The 1931 dry weather samples had shown more moisture for the *Tephrosia* area, but the 1932 samples showed less at all depths (6″-24″) and on all the above-mentioned dates. The weather conditions in the two years were not sufficiently different to account for this, and the cause may perhaps be found in the much more vigorous growth of *Tephrosia* and smallness of the teak plants in the 1932 experiment as compared with the 1931.

(*b*) *Changes of soil consequent on afforestation* (Expt. 48).—An initial set of soil samples from the four working circles, *viz.*, *chir*, *sal*, rosewood and teak were taken in 1927 before the plantations could have affected the soil. After 5 years, a second set was taken and analysed by the Biochemist.

The figures appear to shew that the top layers (up to 18″ depth) have become more porous after the afforestation. Nitrates were found to be in greater concentration in the top layers but the organic matter and the moisture fell throughout. Further quinquennial analyses are needed before any conclusions can be drawn.

(*c*) *Cover crops.*—Frost has virtually killed out the *Tephrosia tinctoria* and *Indigofera endecaphylla* experiments which were promising enough. Whereas a dense cover of *Tephrosia candida* was found definitely to raise the mortality of small teak from frost, with clear indications that the reason is lowering of soil temperatures by shading from winter sunshine, a light cover of *Indigofera tinctoria* appears to have protected *sal* sowings of the year.

(*d*) *Effect of grass in irrigated plantations.*—An investigation of the soil moisture with four types of cover, *viz.*, grass only, trees only, grass under trees, and no cover, was laid out in Chhanga Manga plantation of the Punjab in collaboration with the Provincial Silviculturist. The moisture content (down to 30″ depth) was determined at Dehra Dun. Two years' work has shown that the grass plots had a better moisture per cent practically at all depths and at all times of the year. The others in order of superiority were the grass-under-trees, trees only and

no cover. From this it is evident that removal of grass, however desirable on other grounds, does not improve the water economy.

(c) *Methods of working bamboos for maximum sustained yield in quantity and value.*—Experimental plots were laid out in Punjab (Hoshiarpur Division) and in the United Provinces (Lansdowne Division) after discussion with the local authorities. In Lansdowne Division, insect attack on the bamboos and overhead cover are important problems and the effect of burning had also to be taken into account. This work involved selecting, cleaning and measuring a total of 2,227 clumps.

(ix) Reclamation and afforestation.

It was hoped that the stocking of the 200 acres of demonstration plantations had been completed in 1931, but frost and drought killed most of the sowings of 1931 and they had to be done again in 1932.

(a) *Sal working circle.*—A total area of 4 acres was sown with Hoshiarpur, Gorakhpur small-seeded, Kheri, Haldwani and local origins.

(b) *Pinus longifolia.*—7½ acres were sown with Nainital, Hazara, Lansdowne, Chakrata and local origins.

(c) *Rosewood working circle.*—The one remaining compartment was planted up with stumps and 2,750 casualties replaced elsewhere.

(d) *Teak working circle.*—2,300 casualties were replaced in compartments of Burma origin by stump planting.

II.—STATISTICAL WORK.

(i) Yield Tables.

The chief work of the year has been the compilation of multiple yield tables for *Cedrus deodara*, giving crop values for different grades of thinnings. These are the first tables of their kind in India, and represent a commencement on a line of work bound to become progressively more important. A publication on the subject is now in the Press.

A yield table for *Quercus incana* has been taken in hand. This species does not produce definite annual rings in its timber, and the tables are based in the first place on diameter and top height, instead of age and site quality which is the usual method. A special study has been made of methods of indirect determination of age and the results used to transfer the data to an age basis. These computations are nearing completion.

Compilation of stem distribution data for *sal* was also started as the need for data in this field is being keenly felt in connection with yield regulation in working plans.

Crown diameter data for deodar were collected in the sample plots of the Chakrata Division, United Provinces, by a field party under the Experimental Assistant to supplement a set collected in Kulu by the Punjab Silviculturist. This was done on the lines of recent work in Europe, in connection with the multiple tables, to obtain growth statistics for trees developing under optimum conditions of crown and growing space.

In connection with the measurement of standing trees, a field test was made with the sectional ladder constructed in the Institute. The results were decidedly encouraging and it is hoped to improve the ladder on the basis of experience gained, and to make further tests under typical conditions in hills and plains. Trials have already been made with instrumental and photographic methods.

The records of 298 sample plots were received for computation. Of these, 100 were for new plots, 194 for old plots remeasured, and 4 were for temporary plots.

The distribution of these plot measurements by provinces is as follows :—

Provinces.	No. of new permanent sample plots.	No. of old permanent sample plots re-measured.	No. of temporary plots.
Bengal	25	31	1
Burma	8	77	..
Central Provinces . . .	..	1	..
Punjab	21	44	..
United Provinces . . .	1	41	..
Jammu and Kashmir . .	45	..	3
TOTAL .	100	194	4
GRAND TOTAL .	298	..	..

The following statement shows the present distribution of the permanent and temporary plots by species and provinces :—

Statement showing by species the distribution of sample plots, permanent and temporary, in different provinces of India including Burma.

Species.	Number of permanent sample plots in each province.												Number of temporary sample plots in each province.								Grand Total.
	Andamans.	Assam.	Bengal.	Bihar and Orissa.	Burma.	Central Provinces.	Madras.	N. W. F. Province.	Punjab.	United Provinces.	Jammu and Kashmir.	Total.	Bengal.	Central Provinces.	Madras.	N. W. F. Province.	Punjab.	United Provinces.	Jammu and Kashmir.	Total.	
Shorea robusta	..	..	53	91	..	39	10	..	..	132	..	325	..	5	12	..	..	36	..	53	378
Cedrus deodara	..	..	..	..	..	..	..	..	75	44	19	138	..	..	..	..	37	25	..	62	200
Pinus longifolia	..	..	..	..	..	2	..	1	38	32	1	94	..	..	..	4	8	56	2	70	164
Pinus excelsa	..	..	..	..	..	..	..	9	21	14	39	83	..	..	..	5	35	6	1	47	130
Tectona grandis	3	1	11	13	226	38	46	..	..	5	..	343	..	12	..	..	..	1	..	13	356
Dalbergia sissoo	..	..	..	..	..	..	..	..	37	28	..	65	..	..	..	..	2	7	..	9	74
Other species	6	16	111	27	81	14	15	..	14	93	..	377	20	26	11	..	5	9	..	71	448
TOTAL	9	17	175	131	307	93	71	10	185	368	59	1,425	20	43	23	9	87	140	3	325	1,750

The largest number of permanent sample plots for a single species is 343 for *Tectona grandis*, distributed over eight provinces though two-thirds are in Burma. *Shorea robusta* has 325 plots distributed over five provinces. About 30% of the total number of plots are for the coniferous species, about 40% for *sal* and teak, and the remaining 30% for the other species.

The following statement shows the progress made in laying out plots for the species listed by the Silvicultural Conference in 1929 as requiring yield tables. Progress is obviously slow, but it is to be remembered that for most of the species plots are only available in young plantations; actually only nine plots have been added during the year. As noted above, it has been possible to compile provisional tables for *Quercus incana*. Of the remaining species, *Acacia catechu* and *Terminalia tomentosa* are of widest interest.

Species.	Assam.	Bengal.	Bihar and Orissa.	Burma.	Central Provinces.	United Provinces.	Total.	Added since March 1929.
Acacia catechu	..	..	..	2	.	7	9	3
Acacia arabica	..	..	..	..	..	..	..	..
Alnus nepalensis	..	8	..	..	..	..	8	7
Casuarina equisetifolia	..	..	9	..	..	..	9	..
Cryptomeria japonica	..	12	..	..	..	..	12	11
Dalbergia latifolia	..	..	..	..	..	1	1	1
Eugenia jambolana	..	..	..	..	..	8	8	4
Gmelina arborea	2	11	2	8	..	2	25	6
Michelia champaca	..	4	..	..	..	..	4	1
Michelia excelsa	..	2	..	..	..	..	2	2
Quercus incana	..	..	..	..	..	34	34	1
Terminalia myriocarpa	1	8	..	..	..	..	9	5
Terminalia tomentosa	..	1	10	11	1	9	32	5
TOTAL	3	46	21	21	1	61	153	46

The total numbers of permanent sample plots on the records during the last 3 years are as follows :—

1930-31	1,246 plots.
1931-32	1,227 plots.
1932-33	1,425 plots.

Thus there has been a net increase of 98 plots during the year all laid out by provinces. Only 153 files were computed during the year as compared with the record number of 444 dealt with the previous year. This was due to the staff of this section being largely engaged on special computation work mainly in connection with the deodar yield table.

(ii) Volume tables.

Two statistical parties toured during the winter for about 8 week in the Haldwani Division, United Provinces, and collected the following data :—

Species.	Number of trees measured.	
	Standard volumes.	Commercial volumes.
Holoptelea integrifolia	231	228
Bombax malabaricum	87	212
Dalbergia sissoo	29	29

The work of the parties was inspected while in progress by the Statistical Assistant.

Volume tables for *Holoptelea integrifolia* (*kanju*) and *Trewia nudiflora* (*gutel*), in United Provinces, and for *Bombax malabaricum* (*semal*) in Central Provinces, were published.

III.—MISCELLANEOUS WORK.

The chief items of work undertaken during the year were :—

(*a*) Computation of commercial volumes for 2,874 teak trees (Allapilli Range, S. Raipur Division, Central Provinces), and compilation of a volume table from them.

(*b*) Computation of commercial volumes of 504 *sal* trees (Kolhan Division, Bihar and Orissa), and compilation of volume tables from them.

(*c*) Computation of stem analysis data for teak, 76 trees, Burma.

(i) Photographic Section.

The routine work dealt with compares with the previous years as follows :—

——	Negatives made.	Prints made.	Lantern slides made.
1930-31	1,471	2,680	128
1931-32	1,071	2,061	60
1932-33	677	2,276	44
Total at end of 1932-33 . .	3,219	7,017	232

In the interests of retrenchment, the services of the head photographer had to be dispensed with from 13th August 1932, since when all the work has been done by the assistant photographer who fortunately has several years experience in the section.

Of the new negatives, 192 were taken by the Silviculturist on tour in seven provinces, 150 concern the Timber Testing Section, and 335 were new subjects taken at the Research Institute. 288 photographs have been received directly or indirectly from the provinces forming a very useful addition to our collection, but one which might well be far larger. 48 photographs were utilised for illustrating publications of various types.

The usual annual collection of selected silvicultural photos added during the year to the Central and Provincial collections was circulated to all provinces and extra prints prepared as indented. A considerable amount of work was undertaken for the Punjab Silviculturist to bring his recently organised print collection up to date.

A number of stereoscopic photographs have been taken during the year, and are considered decidedly helpful for certain subjects where depth of view is essential, notably sample plots, thinnings and some other experiments. Some photographic tests were also made in connection with the measurement of standing sample trees in sample plots.

The silvicultural specific collection now has 3,501 prints, and the general collection 2,662 prints—of course some photographs are duplicated. These collections made steady progress, but at a disappointingly slow rate, so that it is usually difficult to meet a request for a photograph suitable for reproduction, for any specified subject.

(ii) Records.

Referencing work has nearly kept up with new forest literature coming in during the year, and one or two of the items of arrears have been worked off. As noted last year, much of this work can only be done by title, even where close scrutiny seems called for, and there is an ever-accumulating pile of selected articles by forest research workers in various parts of the world, awaiting attention. Another urgent need is the examination, weeding and summarising of the existing files on general silviculture, with the ultimate view of preparing a compilation of existing Indian silvicultural knowledge to serve as a starting point for further work. The amount of material on the specific ledger files is now so great that a complete revision of Troup's *Silviculture of Indian Trees* (1921) is out of question, and the best line of work would appear to be a gradual revision of the most important species or groups of species, somewhat as is referred to above for *Shorea robusta*.

With the addition of 22 specific and 32 general ledger files, the number of current files now stands at 1,173 specific and 421 general.

There were 89 additions to the library which now contains 916 volumes, including 323 of bound periodicals. A list of important additions with brief notes on each was circulated to Provincial Research Officers as usual.

The available information on two important subjects *The Problem of the Pure Teak Plantation* and *The Importance of the Origin of Seed used in Forestry* was compiled, in the former instancemainly on the basis of reports contribnted by the provinces concerned, and published as Forest Bulletin 78 and Ind. For. Rec. Vol. XVII, Pt. V, respectively. This procedure of publishing up-to-date surveys of existing knowledge on leading silvicultural problems appears to have been found helpful and it is hoped to continue it.

The results of an independent investigation were published as an Indian Forest Record (XVII—IV) entitled *The Sutlej Deodar ; its Ecology and Timber Production* by Dr. R. Maclagan Gorrie.

(iii) Working Plans.

Notes have been written on 17 draft working plans during the year, from 9 different provinces, and the suggestions made have very generally been adopted. This work takes up an appreciable proportion of the Silviculturist's time, but is well worth it.

(iv) Museum.

Work continues on the large scale models of silvicultural systems, that illustrating conversion to uniform with clear felling of irregular forest and *taungya* regeneration having been completed, and various improvements made in the older exhibits. The sixth model representing the strip system is now under construction. The preparation of these models were primarily undertaken to facilitate technical instruction of forestry students, but the museum has a wider appeal and there have been many visitors during the year.

(v) Staff and touring.

The Silviculturist made a tour in the Punjab in May-June 1932 with the Punjab Silviculturist to advise him with regard to research technique most suitable for the numerous new experimental plots laid out by him for study of regeneration problems in fir forest. The opportunity was also taken to inspect the areas selected as perpetual reserves of unworked forest types, and to initiate some crown measurement work required in connection with the new deodar yield tables. The Experimental Assistant toured in Jaunsar, United Provinces, to collect further data on this latter subject, and the Silviculturist joined him there for a few days to correlate the two sets of figures.

In January-February 1933, the Silviculturist made a long tour covering the *sal* forests of the United Provinces, Bengal, Assam, Bihar and Orissa, Madras and the Central Provinces, meeting many local officers in each province for a joint investigation into regeneration and management problems for this species. A draft report was prepared and circulated at the end of the year and the final revision will shortly be published.

The Experimental Assistant spent 3 weeks in Hoshiarpur Division, Punjab, initiating a series of experiments for an investigation on modern lines into problems of bamboo management. At the end of the year, he went to Lansdowne Division, United Provinces, to lay out a corresponding set of plots. The intention is to hand these plots back to the Provincial Silviculturists concerned for maintenance after a final inspection by the Central Silviculturist, as maintenance should be possible locally although the staff was not available for the decidedly laborious initial work.

The Statistical Assistant only made short tours to supervise the work of the field parties in various parts of the United Provinces. Mr. Mahendru's period of deputation after three periods of extension came to an end shortly after the close of the year under report, and he will be greatly missed. During the 4 years he has been in charge of the section, the standard has been considerably raised and there has been a steady output of original work. By dealing so efficiently with all mensuration and statistical work, both routine and special, he has very considerably relieved the Silviculturist, giving the much needed opportunity for developing other activities of the Branch.

The unpublished report on the tour made by the Silviculturist in 1931 of European Forest Research Institutes, was rewritten in the form of a series of articles each dealing with one aspect of silvicultural work, for publication in the *Indian Forester*, in which they appeared monthly from October 1932 onwards.

CHAPTER III.—BOTANY BRANCH.

Systematic Botany.—The systematic study of the Graminaceae of Duthie's Flora of the Upper Gangetic Plain was continued by Mr. R. N. Parker. In this connection a paper on the genus *Cymbopogon* in North-West India has appeared in *The Indian Forester* and a new species *C. osmastonii* was described from the Kheri district. A paper dealing with the systematy of *Vitis rugosa* and allied species also appeared in *The Indian Forester.*

Three other species of forest importance, two from Bengal and one from Burma were described. A new genus of the family Dipterocarpaceae, *Scaphula,* was described and its relationship with the allied genus *Anisoptera* was discussed.

A list of trees and shrubs from the Kashmir and Jammu Forest Circles, Jammu and Kashmir State, by W. J. Lambert, I.F.S., was published as a Forest Bulletin, Botany Series.

Work in connection with a simple illustrated handbook on 40 common Indian trees was undertaken during the year and early completion of this is expected.

Tours.—No tours were made by the Forest Botanist during the year.

Identification of specimens.—796 specimens were identified during the year including a collection of about three hundred specimens for the Bengal Forestry School at Kurseong. The remainder were specimens mostly sent in by Forest Officers from all over India, notably from Burma, Assam, the Punjab and the United Provinces.

Herbarium.—3,376 sheets were added to the herbarium during the year. About half of these are foreign specimens obtained by exchange chiefly from the Natural History Museum at Stockholm, Arnolds Arboretum and the National herbaria at Victoria, Melbourne, and Pretoria, South Africa.

Of the Indian specimens a thousand or more were supplied by the Forest Botanist, Burma, and the rest was made up of smaller collections sent in by forest officers from the various provinces and local collections. A collection of about a hundred specimens of South Indian plants was supplied by the Principal, Agricultural College, Coimbatore. The seed and fruit collections were re-arranged during the year.

Library.—40 books were added during the year in addition to 64 volumes of the usual periodicals.

Arboretum and Fruticetum.—In spite of some inevitable loss due to fungi, insects and unsuitable climatic conditions the arboretum continues to progress favourably. About 50 new plants representing 16 new species were planted out during the year.

The arboretum contains a representative collection of conifers which, though still young, are well-established and progressing favourably. In addition to *Ginkgo biloba, Cunninghamia sinensis, Tetraclinus articulata. Widringtonia cupressoides, Taxodium mucronatum, Callitris glauca* and *Cephalotaxis drupacea*, eleven species of *Juniperus*, ten of *Cupressus* and three of *Araucaria*, from various sources, have been grown.

With the exception of *Pinus longifolia* and *Pinus thunbergii*, some difficulty has been experienced in raising pines at Dehra Dun as they do not grow well beyond the seedling stage. The cause of their failure is under investigation and may possibly be due to some form of "damping off" by fungi or to the absence of necessary soil bacteria.

Of the three ornamental *Cassias, C. javanica, C. nodosa and C. grandis*, which appear to be only forms of one species, *C. javanica* from Burma has already been successfully grown and flowers freely. The other two, *C. nodosa* from Burma and *C. grandis* from Hawaii, are also being tried with some success though they suffer from frost in the Dun and require careful attention. In addition *Cassia multijuga* and *Cassia marginata* have been successfully raised and are now growing vigorously.

An F_2 generation of an apparent hybrid *Terminalia* (*T. arjuna* × *T. tomentosa*) is being raised with the idea of observing the segregation of such parental characters as may prove its hybrid origin.

In the experimental garden several species of exotic tropical grasses were tried with a view to finding out their suitability for use as forest fodder grasses. Of these the *teff* grass (*Eragrostis abyssinica*) was found unsuitable on account of its low yield and not proving perennial under local conditions, but the Rhodes grass (*Chloris gayana*) gave more promising results by proving perennial, reproducing itself freely by suckers and growing luxuriantly. Experiments with this and other grasses will be continued further.

Work in the fruticetum also progresses well and the plots are now becoming well-stocked and representative of their families especially the Leguminosae, Apocynaceae, Rubiaceae, Convolvulaceae, and Verbenaceae. About 200 plants representing nearly 50 new species were planted out.

In the creeper-house it has been possible to raise successfully such frost-tender plants as *Coccoloba uvifera* and *Codiæum variegatum* and also others of shady moist forests such as *Taraktogenos kurzii, Olea lurifolia, Hermannia denudata, Gomphostemma parviflorum* and some species of *Asparagus*, none of which could be successfully grown in the open in Dehra Dun.

Work in connection with the formation of the arboretum has led to inoculation experiments with root-nodule bacteria and as a result of

these the growth of *Casuarina*, *Mundulea suberosa*, *Erythrina fusca* and *caffra* and other plants have been considerably improved.

Supply of seeds.—Copies of a seed exchange list, in which seed of more than 400 species are offered, were distributed to correspondents and their requirements for experimental purposes supplied. In addition to this 17 indents for seed of forest trees aggregating some 3.000 lb. in weight were complied with. The chief requirements are from Java for seed of *Tectona grandis*, *Dalbergia sissoo* and *Dalbergia latifolia*; from South Africa for *Pinus longifolia* and *Cupressus torulosa* and from Ceylon for *Cupressus torulosa*.

Mycology Section.

Root Disease of Shisham (*Dalbergia sissoo*).—Twelve inoculations of *shisham* were made from fresh *Fusarium* cultures obtained locally from diseased trees with twelve controls. The result of these inoculations appears satisfactory. Cultural work in this connection is being carried on.

Gmelina die-back disease.—A preliminary investigation of the disease was carried out during the year. A large number of histological examinations were made of dead twigs, leaf buds and other growing points to locate, if possible, the seat of infection. The soil obtained from pits dug in the plantations has also been examined and possible predisposing ecological factors considered. Attempts have also been made to isolate the causative organism. Two types of fungus have been isolated from dead twigs.

Peridermium himalayense.—The second part of the investigation dealing with the results of inoculation experiments and control methods is complete and is being prepared for publication.

Peridermium indicum.—The morphology of the fungus on *Pinus excelsa* and *Ribes rubrum* has been worked out.

Damping off of forest seedlings in nurseries.—Observations were made on the germination and damping off of the following forest species sown in nursery beds under different soil conditions. *Soymida febrifuga*, *Terminalia tomentosa*, *Dalbergia sissoo*, *D. latifolia*, *Ailanthus excelsa*, *Gmelina arborea*, *Pinus caribaea*, *P. palustris*. Owing to the late sowing of the seed and the very heavy monsoon rains no definite data could be obtained.

Cultural study of wood-rotting fungi.—The stock cultures now include several important fungi some of which are pathogenic, such as *Fomes annosus* and several species of *Fusarium*, some wood-rotting, such as *Polystictus* (*Polyporus*), *sanguineus*, and others semi-parasitic such as *Ganoderma lucidum* and *Polyporus gilvus*. Some of these are maintained

for requirements in connection with mycological research while others, the wood-rotting ones, are maintained for the requirements of the Wood Preservation Section.

Routine work.—The collection and indentification of fungus specimens from Kulu, Kagan and Kumaon is being continued. It is proposed to send many of these to European specialists for identification. Some good specimens of the white-pine blister rust (*Cronartium ribicola*) and *Peridermium indicum* and of the *Cronartium* stage on *Ribes rubrum* have been added to the collections. Attempts are also being made to obtain, by exchange, a collection of *Polyporaceae* and *Thellophoraceae* from Bengal.

A large number of enquiries were received relating to the diseases of various forest trees and rot in timber.

CHAPTER IV.- ENTOMOLOGY BRANCH.

Insects attacking Shorea robusta.

Damage by *Hoplocerambyx spinicornis* which occurred on a minor scale in the Central Provinces, in Dehra Dun, United Provinces, and in Vizagapatam, Madras, was easily controlled by standard measures.

Secondary Borers.—The dying-off of several thousand *sal* trees over about 3,000 acres in Haldwani, United Provinces, was investigated. The stagheaded and moribund symptoms associated with dry crown borers were followed by the establishment of *Gerontha captiosella*, *Diorthus simplex* and *Acolesthes holosericea*, while *Hoplocerambyx* and pinhole borers were almost completely absent. *Gerontha captiosella*, a tineid moth, is usually an uncommon insect but on this occasion occurred in epidemic incidence. Its attack is associated with a carbonisation of the phellogen layer beneath the dead corky bark which has all the appearance of scorching due to departmental burning, but the possibility of its being a new disease is under investigation.

Control measures for the protection of undamaged timber were devised and adopted by the division. Nearly four thousand commercially useless *sal* were felled as trap-trees.

Similar dying-off on a smaller scale was reported from Dehra Dun division.

Insects attacking Tectona grandis.

Dihammus cervinus.—Food preference experiments were carried out with beetles bred from *Clerodendron infortunatum* in the laboratory. The ovipositing females showed no marked preference either for teak or for *Clerodendron*; the number of plants attacked and the number of eggs laid was approximately the same for each host plant. *Vitex negundo* and other controls were avoided.

The life-cycle was again determined as of one year's duration, — July 1931 to July 1932..

The sample plots in Haldwani Division, United Provinces, showed an increase in incidence from 1930 to 1931 and a fall to 1932. The increase was relatively greater, and the decrease relatively less in the unweeded areas than in the weeded areas. The average incidence however was low—the cankered and broken stems not exceeding six per cent.

Hyblaea puera.—Food preference experiments were undertaken with moths raised from wild larvae collected on teak. A choice of teak, *Premna latifolia*, *Vitex negundo* and *Callicarpa arborea* was provided

in the outdoor insectary. In one experiment the greatest number of eggs was laid on teak, and the next greatest on *Premna*. In a second experiment 8 days later abundant oviposition occurred on *Premna* and teak was scantily visited.

Kigelia pinnata coppice shoots are reported to be eaten by *Hyblaea puera*.

Amsacta lactinea (Arctiidae) has been bred on teak, *Clerodendron* and *Vitex*. The life-cycle is about two months.

Hapalia machaeralis.—An alternate foodplant is *Tectona hamiltonii*.

Parasites and Predators.—New records include a *Microbracon* parasitising the larva of *H. machaeralis*; a *Brachymeria* and a *Tetrastichus* parasitising the pupa of *H. machaeralis*. A species of *Monolexis* parasitic on the larva of the bamboo leaf roller, *Pyrausta coclesalis*, has also been bred from *H. machaeralis*.

Acherontia styx is parasitised by *Agiommatus acherontiae* and *Sturmia chatterjeei*.

Predators of teak defoliators have received further attention. *Chlaenius rayotus* and *Calleida rapax*, carabids, feed as larva and as beetle on *puera* and *machaeralis*; other carabids, *Parena nigrolineata* and a *Glycia* also feed on *machaeralis*; a mantid, *Hestiasula brunneriana* is an enemy of *puera*; *Xanthandrus indicus*, a syrphid, preys upon *puera* larvae. Among the spiders a species is under study; one individual devoured 70 larvae and moths of teak defoliators in six months.

These and previous records show that there are very diverse and effective natural limiting factors that can be put to good use in the biological control of teak defoliation.

The defoliation records under the Nilambur five year plan were completed and maps prepared. The ecological work proposed for the current year was postponed.

Spike Disease of Sandal.

Analyses of Collections.—The analysis of the fauna of sample plots was continued; records of seasonal incidence and distribution of seven families were wholly and of six families were partially completed.

In three sample plots situated in special observation areas in North Salem the numerical abundance of the sucking insects was found to be approximately the same in each plot. Jassids, which constitute about three-tenths of the hemipterous population, were equally abundant in all three plots; fulgorids were as abundant as jassids in one plot, but only three-fifths as abundant in the two other plots. The most abundant scar-making species were *Acropona walkeri* (equally numerous in the

spiked areas), *Petalocephala nigrilinea* and *Moonia albimaculata*, (not equally numerous), *Bythoscopus indicus* and *Ledra mutica* (relatively much less numerous). Together these five scar-making insects formed about a quarter of the hemipterous population in each plot and the incidence of spike was practically the same in each plot. These data tally with the evidence from other sources that the intensity of attack on sandal as measured by scars is roughly proportional to the disease incidence.

The study of the fauna of six host-sandal combinations in healthy and spiked areas has been concluded and one combination remains to be studied. Nearly 22,000 specimens are involved in these analyses. The relative incidence of species in the restricted host-sandal environment is found to differ considerably from the relative incidence in the region as a whole, indicating that the local insect population frequenting sandal is greatly influenced by the proximity of hosts, *e.g.*, the membracid, *Otinotus oneratus* is the commonest species on sandal in the general quantitative collections, but in the host-sandal combinations it is rare, being replaced by *Coccosterphus tuberculatus*. The most abundant insect on spiked sandal in the host-combinations is *Aeropona walkeri* a species that is absent from localities where spike does not occur.

Taxonomy of Sandal Insects.—Nine reports on the identification of sandal insects and the description of new species have been prepared by specialists and sent to press, *viz.*—Carabidae by H. E. Andrewes; Neuroptera by N. Banks; Bostrychidae, Scolytidae and Platypodidae by C. F. C. Beeson; Exocentrus by W. S. Fisher; Membracidae by W. D. Funkhouser; Cicindelidae by W. Horn; Anthribidae by K. Jordan; Brenthidae by R. Kleine; Cercopidae by V. Lallemand. These cover 225 species which comprise only a small fraction of the insect fauna of sandal.

Bionomics of Sandal Insects.—Work in progress last year was completed. The alternate foodplants of some common sandal insects have been determined. Aphids, psyllids and thrips which appeared to be rare on sandal were obtained in abundance in the host-group collections.

Bionomic work at Bangalore by Messrs Dover and Appana was restricted to the life-histories of 12 species. Papers on the sandal fulgorids, *Sarima nigroclypeata* and *Eurybrachys tomentosa*, and the common jassid *Petalocephala nigrilinea* have been prepared for publication by Mr. N. C. Chatterjee.

Transmission Experiments.—Work at the sandal spike insectary in the Indian Institute of Science, Bangalore, concentrated attention on transmission experiments embracing the largest number of apparently influencing factors. The essential principal was the introduction of "infective" insects on healthy plants for a definite period, after which

the plants were pruned to force out the symptoms of the disease. Experiments were conducted with individual species, groups of species, and a heterogeneous assemblage of species. In the first category 226 experiments, many of which were initiated by Mr. N. C. Chatterjee, were concluded by Messrs C. Dover and M. Appana during the year. Many more are in progress. Eighteen experiments with various groups were completed.

A capacious outdoor cage containing some 150 sandal plants and an average population of 20,000 insects served as an experiment of the third category and for the maintenance of a reserve supply of sandal insects.

Results show that (1) the leaf disease (chlorosis) caused by weevil attack did not persist in the new flush after pruning, and further experiments with weevils did not reproduce this symptom; (2) that spike-fed *Moonia, Petalocephala* and *Acropona* may produce a condition in previously healthy plants that bears a distinct resemblance to spike disease; and (3) that only a very limited number of species are able to survive on sandal sufficiently long for experimental purposes.

Experimental evidence as to the existence of an insect vector of spike disease is thus still negative, but theoretical considerations based on the natural infection of exposed pot plants and the non-infection of plants protected by insect proof cages admit the probability of infection by an agent moving above ground level. A summary of the results of preliminary transmission experiments has been prepared for publication.

Field collections were made in special areas, which confirmed the list of probable vectors furnished by the results of the quantitative surveys.

Bamboo Defoliators.—Five species of Pyralidae feeding on bamboo leaves were studied. *Pyrausta coclesalis* was found to hibernate as a larva until the end of May. Four generations are passed during the year with defoliation mainly during the monsoon period. The caterpillar moults six times.

Other species are *Massepha absolutalis*, and *Glyphodes indica*. The carabids *Calleida splendidula*, *C. rapax*, *C. pallipes* and *Chlaenius nayotus* are important predators of the caterpillars.

Bamboo Borers.—The project in which bamboos felled fortnightly were exposed to *Dinoderus* attack was completed and the incidence of damage analysed. Strength tests carried out by the Timber Testing Section showed that there is a distinct loss of strength on the average when the number of borer holes approaches 200 per six foot length but that there is no constant relation between the amount of borer attack and the strength of the specimen, *e.g.*, the three weakest pieces contained 5 bore holes and one with moderately high strength had 143

holes. Taking 10 holes as a defect sufficient to reject the bamboo for highest quality purposes it was found that 68 per cent of the material was sound at the end of 1½ to 2½ years.

The liability to damage varied throughout the year being least in bamboos felled from mid June to the end of July and highest in fellings from the end of December to May.

The safest period to fell bamboos is at the end of the hot weather and in the first month of the monsoon, and the next best period is from the end of the monsoon to the beginning of the cold weather (mid October to mid December for Dehra Dun).

No benefit is obtained by storing bamboos in the shade. Antiseptic treatment tests indicated that soaking in 2 per cent sodium fluoride in an open tank for at least 5 hours and slow cooling for a day gave practically complete protection. Creosote and fuel oil, " celeure " and salt solution were not beneficial. Smoking gives no protection.

The phases of the moon do not influence the liability to attack.

Estigmena chinensis and *Cyrtotrachelus longipes* are reported to be serious pests to growing bamboo.

Deodar Nursery Insects.—Insect conditions in deodar nurseries in Chakrata, United Provinces. were examined in June. In the seed beds fresh damage by cutworms was practically negligible—it is believed to occur much earlier in the year. In these seed beds a half to almost the whole of the mortality may be ascribed to causes other than insects. In the transplantation beds the one year old transplant is subject to attack by cockchafer grubs, which are responsible for as much as half the total mortality, the remainder being due to causes other than insects. In the second transplantation beds, with transplants 2 years old and over, mortality due to various factors including defective cultural operations was found to be high. Of the total casualties cockchafers were responsible for 10 to 30 per cent. Insects are apparently of less importance than are other factors causing the death of deodar plants between the ages of 6 and 30 months. The importance of cutworm damage in the spring will be studied next season.

Gamari Insects.—Calopepla leayana.—Further experiments with artificial hibernation shelters were conducted without discovering any practical procedure.

The parasite *Brachyneria* was bred through three generations and its life-cycle data rechecked—while the life-cycle is completed in a fortnight the adult fly lives from September to February, and for three months of this period without food.

Hollock and Pterocarpus marsupium Borers.—A large number of species of *Xyleborus* and other pinhole borers, with weevils and longi-

corns and bostrychids and *Dihammus* and *Phassus* were bred from branch and stem wood of *Terminalia myriocarpa* dying in plantations in Assam. The diversity and irregular occurrence of the fauna indicated secondary attack on weakly resistant trees. The primary cause of the dying off was attributed to excessive density.

A mixed borer fauna was reared from dying *Pterocarpus marsupium* in plantations in Coorg.

Shisham Insects.—The life-history of the leaf miner *Leucoptera sphenographa* was studied and hibernation as moth was determined. Oviposition from overwintered moths commenced in March.

Borers of Timbers.—General collection and rearing continued on standard lines. Special attention was given to the distribution and food plants of indigenous lyctids in connection with which timber yards in Calcutta and Bombay were visited. Results were summarised and published. Material used as dunnage by shipping leaving Indian ports for Europe was examined and its borer fauna reared.

The borers of *semul* (*Bombax malabaricum*) were specially studied and planks were subjected to bostrychid attack after treatment with antiseptics.

Termites.—Treated test pieces were distributed to various parts of India for exposure to attack by termites. During the period of 6 to 12 months all the antiseptics under test completely protected the wood.

General Insectary Work.

During the year 97 consignments of attacked material and insect specimens were received from various forest divisions of India for identification, etc. In the Insectary experiments in 389 cages were discontinued and 295 are still in progress. The total number of insects bred out was 35,875 and of these about 10,860 were set and labelled.

The local gall-making Psyllidae were studied :—*Pauropsylla depressa* (leaf galls on *Ficus glomerata*), *P. beesoni* (leaf galls on *Litsaea polyantha*), *Phacopteron lentiginosum* (leaf galls on *Garuga pinnata*), *Euphalerus vittatus* (on *Cassia fistula*), *Diaphorina citri* (on citrus), *Trioza jambolanae* (leaf galls on *Eugenia jambolana*), *T. fletcheri* and *Phylloplecta hirsuta* (leaf galls on *Terminalia tomentosa*) *P. malloticola* (leaf galls on *Mallotus philippinensis*).

Systematic Entomology.

The greater part of the time of the staff of this section was occupied in arranging and identifying the very large collections made during the sandal spike investigations, as in the previous year. Most of this work has been completed and several reports from specialists are ready for the press.

The number of insect species in the collection has been increased by 300. The collection of immature stages has been considerably augmented, particularly in beetle larvae. Four papers by the Systematic Entomologist on beetle larvae of economic importance were prepared for publication. Numerous papers by specialists on material from this Institute other than that connected with the sandal investigations have appeared in various scientific journals. Important advances in the taxonomy of Indian termites have been made by Dr. T. E. Snyder of the U. S. Bureau of Entomology; a paper by Dr. Snyder on new Indian species will appear shortly.

Tours.—By Mr. J. C. M. Gardner to Bangalore (Spike Conference) and North Salem, Madras in April. By Dr. C. F. C. Beeson to Ranchi (Lac Cess Committee) in November and March; to Haldwani, United Provinces in February; to Calcutta in November; to Bombay in March. *By Mr. N. C. Chatterjee in North Salem, Madras in April-May.* By Mr. C. Dover to Bangalore, Coimbatore, North Salem and Fraserpet, Coorg. By Mr. B. M. Bhatia to Chakrata, United Provinces in June; to Haldwani, United Provinces in February; to Bombay in March. By Mr. S. N. Chatterjee to Haldwani, United Provinces in April and February.

Lectures.—The course in Forest Zoology for the Indian Forest Service Class was conducted by Mr. N. C. Chatterjee—thirty lectures and thirty hours of demonstrations.

Mr. C. Dover delivered a public lecture on the entomology of spike at Bangalore and attended a symposium on spike disease at Coimbatore.

Museums.—About 160 specimens of damage to timbers by borers were added in the main hall, and a gallery opened for the display of damage by defoliators.

Charts and specimens were added in the museum of forest zoology.

Library.—136 books besides periodicals were added to the Zoological Library during the year.

Publications.—A list of all publications and articles in scientific journals is given in Appendix I.

CHAPTER V.—ECONOMIC BRANCH.

Wood Technology Section.

1. *Research.*

(*a*) Work in connection with the preparation of a hand lens key for the identification of important commercial timbers of the Punjab is almost complete. All photomicrographs (X 10) are ready, and the Bulletin will be sent to the press soon.

(*b*) 'Growth studies in some north Indian forest trees' were continued. 80 micro-blocks were taken from 7 different trees. Numerous sections have been cut, and the anatomical structure and micro-chemical reactions noted. The investigation will be continued with a view to establishing the results so far obtained, in the light of recent research done in European countries.

(*c*) Research on the anatomical study of woods of the Indian Dipterocarps was continued. Over 70 authentic specimens have been microscopically studied. More specimens will be taken up for study during next year.

(*d*) Experiments in connection with the improved method of softening micro-blocks in hydrofluoric acid have been continued with success.

(*e*) The anatomical study of some Indian woods in connection with their liability to attack by *Lyctus africanus* was completed. The results of this investigation have been published in *The Indian Forester*.

(*f*) The study of the wood of three varieties of *Terminalia tomentosa* has been continued during the year. Both Burma and Madras are interested in this enquiry.

2. *Identification of wood.*

Many wood samples were received for identification from various branches and sections of the Institute. Enquiries were also received from outside sources such as :—

(*a*) Chief Engineer, Madras and Southern Mahratta Railway.

(*b*) Messrs. H. Dear & Co., Ltd., Calcutta.

(*c*) Works Manager, Moghalpura, North Western Railway.

(*d*) Superintendent, Gun Carriage Factory, Jubbulpore.

(*e*) Chief Engineer, South Indian Railway, Madras

(*f*) Birla Jute Manufacturing Co., Ltd., Calcutta.

(*g*) The Commissioner for the Port of Calcutta.

(*h*) Director-General of Commercial Intelligence and Statistics, Calcutta.
(*i*) R. E. Mody & Co., Bombay.
(*j*) Messrs. Bird & Co., Calcutta.
(*k*) Chief Engineer, Eastern Bengal Railway, Calcutta.

During the year under review 400 specimens were identified.

3. *Examination for fungus.*

Various enquirers sent wood specimens, suspected of having been attacked by fungus. The number of specific enquiries replied to in this connection was 30.

4. *Special enquiries.*

Several special problems were taken up on behalf of the officers of the Institute and forest officers in the provinces. Technical information was also supplied to other enquirers from various parts of India.

5. *Accumulation of anatomical data.*

In course of routine work, over 120 data sheets were filled up and filed for future reference.

6. *Collection of authentic wood specimens.*

(*a*) In India :—For the authentic collection 310 wood specimens were received from different parts of India.

(*b*) From abroad :—During the year altogether 129 wood specimens were received from the Federated Malay States and Australia, to whom thanks are due for helping to make a complete collection of commercial timbers of the world.

7. *Distribution of wood specimens.*

In response to requests from abroad and from various parts of India over 800 samples of timber were sent out to interested enquirers.

8. *General.*

The usual course of wood technology was given to the Indian Forest Service students.

Over 150 photomicrographs were sent to various persons interested in wood identification. The curator of the Lord Reay Industrial Museum, Poona, was supplied with 50 photomicrographs of various timbers and bamboos for exhibition in the museum.

9. *Publications.*

See Appendix I.

Timber Testing Section.

1. *Staff.*

It was again necessary for the sake of economy in material and power to work the laboratory and computing office intermittently. This has, however, helped a great deal in clearing the arrears of computation work and bringing it in line with the laboratory work.

2. *Special investigations.*

(a) *Effect of borer holes on bamboos.*

The study started last year to investigate the effect of different methods of storage on the degrade and loss in strength of bamboos has been finished. Attack by boring insects was found to result in a considerable reduction of strength, but from the data so far available it was not possible to establish any definite relation between the number of borer holes present and the degrade, as the strength appeared to be adversely affected by other factors in addition to insect attack.

(b) *Method of testing shear.*

A new shearing tool in which friction was reduced by the use of roller bearings was designed and constructed, and a number of tests were made to examine the accuracy of results obtained with the standard shearing tool. This investigation is still in progress.

(c) *Holding power of patent nails.*

Tests were made on the holding power of the "Stronach" patent non-splitting nails. Ordinary pointed nails and the patent nails were driven to an equal depth in different species of wood and the force required to pull each nail out was noted. The tests were made by standard methods taking every precaution to assure similarity of conditions. From the tests so far made, it appears that there is no important difference between the patent nails and the ordinary pointed nails either in holding power or in their tendency to split the wood.

(d) *Penetration of moisture through wood coatings.*

A study of the resistance offered to the penetration of moisture by various types of wood coating was started, but results so far obtained are not very definite.

(e) *Suitability of "Fridera" composition for bridge girder packing.*

An investigation as to the suitability of "Fridera" composition for use as a packing between bridge sleepers and steel girders was started as the result of enquiry from the Railway Board and several tests were made on the brittleness, hardness and plasticity of "Fridera."

(f) *Testing of glue joints for Ground Engineer's Licence.*

An important addition to the former programme of work was the testing of glue joint specimens submitted by ground engineers of the flying clubs of India. This study was undertaken at the request of the Inspector of Civil Aircraft and complies with the specifications of the British Engineering Standards Association. It is most gratifying to note that the quality of the work submitted by the ground engineers has shown a very substantial improvement since the timber testing laboratory undertook to check the work. This has had the effect of making the repair work of aircraft more dependable and flying safer.

3. *Routine testing.*

The output of results from routine testing was very much affected by the reduction of staff. Work was continued under Project 1 (Standard Tests of Small Clear Specimens) and Project 2 (tests of timbers in Structural Sizes). Tests of glues, plywood and tea boxes were also continued in co-operation with the Veneer Section.

No. of species tested during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	1	8	2	
Project 2	2	2	..	
Project 0 under various sub-heads				48 species.
Charcoal briquette tests				4 consignments.
Tests of glue joints for aircraft				22 consignments.
"Fridera" composition tests				10 consignments.

No. of species computed during the year.

	Green.	Air dry.	Kiln dry.	
Project 1	2	8	1	
Project 2	1	2	..	
Project 0 under various sub-heads				48 species.
Charcoal briquette tests				4 consignments.
Tests of glue joints for aircraft				24 consignments.
"Fridera" composition tests				10 consignments.

Over 10,000 mechanical tests and 11,000 physical determinations were made in the laboratory during the year. Besides finishing the

might still be far from satisfactory, on account of excessive cracking and splitting of the timber during the dry summer months.

A new process of kiln drying has been evolved by Dr. S. N. Kapur, Officer in Charge of the Section, by which this liability to the formation of moisture pockets (with the resultant case-hardening of wood) is greatly reduced. Any kiln, which is fairly air-tight and is equipped in the interior with the usual heating coils and propeller fans, is good enough for the new process. Briefly stated, after the kiln is loaded with timber and doors tightly shut, the fans are put into operation, and steam is allowed into the heating coils till the air is heated to the required temperature, when the steam is shut off and the air circulation continued till there is no further increase in the humidity of the air inside. At this stage the dampers are opened to exhaust the used air and to admit a fresh charge of air, which is again heated and circulated as before.

If the kiln is of fairly air-tight and water-proof construction, the air inside the kiln, which gets fairly dry during the heating stage, absorbs moisture from the wood and soon gets saturated, as long as the wood is above the fibre saturation point. Below the fibre saturation point the final humidity attained by the circulating air depends on the moisture content of the wood at that particular stage of drying. At the end of each cycle, any moisture gradient developed in the wood is automatically eliminated, the surface layers remain practically saturated, and case-hardening is almost entirely avoided.

It is interesting to note some of the results that have been obtained :—

(i) *Terminalia tomentosa.*—It usually requires (for one inch thickness) about 25 days to kiln-dry this wood from the green condition, containing about 75 per cent to 80 per cent moisture, with very frequent steaming operations during the kiln run. With the new process the drying was completed in 14½ days, and the dried material was found to be in perfect condition. After further experimentation it is hoped to be able to reduce the drying period to about 10 or 12 days.

(ii) *Dipterocarpus macrocarpus.*—One inch boards were dried in 12 days from green to 10 per cent moisture content. This timber is very difficult to kiln-dry according to the usual methods on account of the presence of oleo-resins. The condition of the dried timber was excellent.

(iii) *Terminalia myriocarpa.*—One inch boards containing up to 120 per cent moisture were kiln-dried in less than 11 days. The final condition was extremely satisfactory.

Similar good results were obtained with *Anogeissus latifolia* 2½" × 2½" sticks, *Machilus macrantha* ⅝" thick planks, *Terminalia paniculata*

1" planks, and *Stereospermum chelonoides* $\frac{3}{4}$" thick planks.

The advantages of the new process are that :—

i. It is easy to operate,

ii. It requires much less steam,

iii. Is more economical and

iv. Produces dried timber of very good quality.

The investigations on this new process are still under progress and the results quoted above are by no means final.

2. *Effect of various preliminary treatments on the seasoning of wood.*

There are some timbers which, in spite of the best care under air or kiln seasoning, are prone to surface cracking, an example being *Anogeissus latifolia*. Experiments were undertaken to determine whether any preliminary treatment can help in overcoming this difficulty. The following treatments were carried out :—

(1) Soaking in water for various periods from $1\frac{1}{2}$ to 4 months.

(2) Boiling in water for 4 and 12 hours respectively.

(3) Steaming under pressure for various periods.

(4) Application of a coat of animal glue in aqueous solution to all the surfaces of timber.

(5) Application of a 50 per cent aqueous solution of glycerine to all the surfaces of timber.

The timber (*Anogeissus latifolia*, $2\frac{1}{2}$" × $2\frac{1}{2}$"), after the various preliminary treatments stated above, was kiln-dried in an internal fan kiln. It was found that in the untreated lots, the loss due to the increase of surface cracking during seasoning was anything from 21 per cent to 36 per cent of the total volume. The least degrade was in the case of timber coated with glycerine solution (3·1 per cent), the next being soaking in water for $1\frac{1}{2}$ months (4·4 per cent). The material is under test for effects on the mechanical and strength properties, shrinkage, hygroscopicity, etc., and a report will be issued during the coming year.

A similar experiment on *Juglans regia* was carried out, and a number of other species treated more or less on the above plan are under air-seasoning. In some cases, the effect of inorganic hygroscopic salts, such as calcium chloride, is also being investigated. It is hoped that this investigation may lead to some cheap method of seasoning hardwood sleepers without excessive cracking and splitting.

3. *Air seasoning.*

The practice of stacking small quantities of timber left over from material from Project VII was continued. During the year 10 species

were added, and the data obtained have confirmed the results reported last year.

4. *Vacuum drying of timber.*

An experiment with *Anogeissus latifolia* indicated a certain amount of success. From an initial moisture content of about 42 per cent. the timber came down to 7 to 8 per cent in the case of sapwood pieces, and 20 to 22 per cent in the case of heartwood pieces in 166 working hours. The vacuum pump, however, worked for 28 hours only. The surface cracking was not excessive. The difficulty lies in creating sufficient circulation of air in the rarified atmosphere inside the cylinder, which is very necessary for the proper drying of wood. In this connection certain improvements are under consideration, which will be tried later on.

5. *Ozone drying of wood.*

A few sticks of *Dipterocarpus alatus* (*gu jan*) were dried under controlled conditions, with the regular addition of ozone. The experimental observations were not complete at the end of the year.

6. *Seasoning of softwood railway sleepers.*

A report on the air-seasoning experiments carried out in the Punjab at the end of 1931-32 was issued, and copies were circulated to the authorities concerned. It is proposed to carry out a further series of experiments on a larger scale during the winter of 1933-34 at the Forest Research Institute, where greater control can be applied than is possible in out of the way depots.

7. *Shrinkage tests.*

Shrinkage experiments on small clear specimens were continued, and five more species were taken up during the year. The scope of the experiments has been broadened so as to give information on the following points:—

(*a*) Total shrinkage from green to air-dried and oven-dried conditions.

(*b*) Rate of shrinkage.

(*c*) Equilibrium moisture content at various relative humidity conditions.

(*d*) Rate of swelling and total swelling at various humidities.

(*e*) Rate of absorption of moisture on transfer from a lower to a higher relative humidity.

(*f*) Effect of various treatments of wood, such as soaking in water, boiling, steaming, etc. on the shrinkage, swelling and hygroscopicity of the wood.

8. *Specific gravity.*

The modified method of determining specific gravity by the Archimedes principle reported last year proved quite useful, and the experiments were continued. Two more species were taken up during the year.

9. *Methods of determining moisture content.*

An investigation was carried out during the year into the accuracy and reliability of various methods of determining moisture content of wood, and it was found that the usual method of oven-drying at 100°C., and the method of distilling off water with some organic solvent like xylol or toluene gave practically identical results, except in the case of woods containing volatile oils. The difference was found to be considerable in the case of *Cedrus deodara* and the investigation in case of this timber was pursued in detail. A study of the results obtained with 12 different samples of *Cedrus deodara* gave a range of 1·64 per cent to 12·17 per cent for the difference in the moisture content values obtained by the two methods, the average figure being 7·10 per cent. This in fact represents the percentage of volatile oils (based on the oven-dry weight of the wood), which are evaporated off along with water during the oven-drying process. It is therefore evident that the oven-drying method is practically useless for the determination of moisture in *Cedrus deodara*, particularly where reliable and accurate results are desired.

10. *Lillooah kilns.*

The installation of seasoning kilns at the workshops of the East Indian Railway continued to run satisfactorily under the supervision of the officer in charge of the Seasoning Section. A visit was paid by him during August 1932. At the end of the year, on account of lack of demand of seasoned timber, the kilns were temporarily shut down, but it is hoped that they will be again put into operation at an early date.

11. *New commercial installations.*

It is satisfactory to report that during the year two business firms decided to erect seasoning kilns at the advice of, and according to the designs supplied by, this section. These kilns are in course of erection, one at Margherita in Assam and the other in Calcutta. Since the pro-

cess of kiln-drying has been greatly simplified, there is great scope of expansion in this direction.

12. *Enquiries.*

During the year, about 2 dozen enquiries were dealt with by the section on various subjects relating to air and kiln seasoning of timber. The erection of the two new kilns mentioned above is a direct result of these.

13. *Publications.*

The " Report on the Air-seasoning Experiments on Softwood Railway Sleepers in the Punjab", by Dr. S. N. Kapur was published in the Railway Board Quarterly Technical Bulletin, Vol. III, No. 29, April 1933.

14. *Tours.*

While on tour to Lillooah, in August 1932, a visit was paid to the Government Rifle Factory at Ishapore, in connection with their enquiry regarding honey-combing of walnut during kiln-drying.

Wood Preservation Section.

1. *Work under Project IV.*

Sleepers of the following species were treated with creosote and with mixtures of creosote and crude oil, during the year.

	Number treated.
Pterospermum acerifolium M. G.	161
Kayea assamica M. G.	137
Acrocarpus fraxinifolius M. G.	200

Only the *Parashorea stellata* sleepers from Burma now remain to be treated under Project IV. They were not ready for treatment by the end of the year.

2. *Toxicity tests with arsenical and other preservatives.*

Preliminary laboratory tests for determining the relative toxicity of a number of chemicals against the bamboo borer (*Dinoderus* sp.) were conducted. Arsenical compositions appeared to be the most toxic for a unit of money.

Field tests for determining the relative permanence and the critical toxic concentration for protecting wood from termites and fungi of the following wood preservative chemicals were inaugurated :—

1. Arsenic pentoxide.

2. Arsenic trioxide.
3. Powell solution.
4. Thanalith U.
5. Falkamesam.
6. Colloidal arsenic tri-sulphide.
7. Copper sulphate.
8. Zinc chloride.
9. Celcure.
10. Mercuric chloride.
11. Sodium dichromate.
12. Sodium fluoride.
13. Zinc meta-arsenite.
14. Coal tar creosote.
15. Fuel oil.
16. Coal tar creosote and fuel oil (1 : 1).
17. Coal tar creosote and fuel oil (1 : 2).
18. Coal tar creosote and fuel oil (1 : 3).
19. Coal tar creosote and fuel oil (1 : 4).
20. Creosote fraction (200°C. to 220°C.).
21. Creosote fraction (220°C. to 245°C.).
22. Creosote fraction (245°C. to 260°C.).
23. Creosote fraction (above 260°C.).
24. Barium hydroxide.

The results up to date indicate the efficacy of copper sulphate and mercuric chloride, besides that of the arsenical preservatives; the lighter creosote fractions do not appear to be, on exposure to the elements, effective against termites. These tests are, however, still in progress.

3. *Adsorption tests with arsenical preservatives—especially Falkamesam.*

Several experiments, conducted to determine the relative adsorption in wood of arsenic with three typical arsenical wood preservatives, showed that, under ordinary conditions of treatment, this phenomenon does not seriously interfere with their use in commercial plants. Under commercial conditions, adsorption has to be allowed for; and occasionally the concentration of the solution must be determined and brought up to the initial concentration.

4. *Experiments on fixing copper and arsenic compounds in wood.*

In view of the high efficacy of copper against white ants, experiments were made with success to fix copper as well as arsenic in wood. Experiments in this connection are being continued.

5. *Field experiments with Falkamesam.*

At the instance of the Railway Board, nine hundred *chir* (*Pinus longifolia*) B. G. sleepers were treated with Falkamesam and sent to the North Western Railway for field test. Three hundred of the sleepers were also given an anti-splitting treatment consisting of dipping in a 10 per cent solution of a bituminous composition in crude oil.

6. *Advice to the Governments of Madras and Mysore regarding the use of treated timber.*

At the request of the Governments of Madras and Mysore, the officer in charge visited Madras and Bangalore, to advise several heads of departments regarding the use of treated timber. At the request of the Director of Agriculture, Madras, experiments were made to investigate the treatability of *Eucalyptus globulus*, *Casuarina equisetifolia* and *Borassus flabelliformis* (palmyra). The results indicated that the first two species could be treated satisfactorily in the sapwood, so that they could be better utilised in the round than in sawn timber in which the heartwood is exposed; whereas palmyra can be preserved very satisfactorily throughout.

7. *Water-proofing and anti-splitting treatments for wood.*

During the year, several preliminary tests were made to investigate the efficacy of cheap bituminous compositions (suspended in crude oil) to prevent splitting by water-proofing wood. These experiments yielded results that may be expected to lead to a special treatment of railway sleepers and structural timbers.

8. *Graveyard tests.*

Wood specimens treated with the following preservatives were laid down in the antiseptic test yard for durability trials against fungi and termites:—

1. Falkamesam.
2. Arsenic pentoxide.
3. Arsenic trioxide.
4. Ceasrot.

5. Presotim.
6. Thanalith U.
7. Treated plywood (82 pieces from Germany).
8. Sundeala boards.
9. Treated insulation boards.

During the year, untreated sticks of the following three species were laid down for test against termites :—

1. *Ulmus wallichiana*.
2. *Morus serrata*.
3. *Mimusops elengi*.

All the specimens under test in the antiseptic test yard were inspected twice during the year, and in the case of proprietary preservatives, reports were sent out to those concerned.

Pieces of wood treated with the following wood preservatives, and also those that were, after treatment with the preservatives, shaken (in a machine) 20,000 times with water, were laid down about the middle of 1932 in white-ant infested ground at Dehra Dun, Madras, Bangalore, Pusa, and Calcutta. All the pieces appear to have remained sound and intact according to the reports received about them.

1. Falkamesam (0·5 per cent. $As_2 O_5$, $2H_2 O$).
2. Falkamesam (1·0 per cent. $As_2 O_5$, $2H_2 O$).
3. Falkamesam (1·5 per cent. $As_2 O_5$, $2H_2 O$).
4. Zinc meta-arsenite (0·5 per cent. $As_2 O_3$).
5. Zinc meta-arsenite (1·0 per cent. $As_2 O_3$).
6. Zinc meta-arsenite (1·5 per cent. $As_2 O_3$).
7. Powell solution (0·5 per cent. $As_2 O_3$).
8. Powell solution (1·0 per cent. $As_2 O_3$).
9. Powell solution (1·5 per cent. $As_2 O_3$).
10. Coal tar creosote.
11. Coal tar creosote fraction (above 245°C).
12. Coal tar creosote fraction (below 245°C).
13. Coal tar creosote and fuel oil (1 : 1).
14. Coal tar creosote and fuel oil (2 : 3).
15. Coal tar creosote and fuel oil (3 : 7).
16. Fuel oil.
17. Wood tar creosote.
18. Wood tar creosote fraction (above 230°C).

19. Wood tar creosote fraction (below 230°C).
20. Wood tar creosote and fuel oil (1 : 1).
21. Wood tar creosote and fuel oil (2 : 3).
22. Wood tar creosote and fuel oil (3 : 7).

9. *Tests against marine organisms.*

Thanks to the courtesy of the Bombay and Madras harbour authorities, test pieces treated with creosote and Falkameram were sent to the Chief Engineers of the two harbours concerned for exposure to attack by marine organisms.

11. *Publications.*

A Forest Bulletin entitled "Testing and Selection of Commercial Wood Preservatives" was sent to the press towards the end of the year.

Wood Working Section.

1. *Wood Workshops.*

In addition to supplying other Sections with converted material for research purposes, a large variety of work of maintenance was carried out *e.g.*, flooring, measuring sticks, handles, tables, platforms, switch boards, tea chests, boxes, guards, showcases, ladders, drawing boards, frames, glue joints, aircraft specimens, seats, callipers, brackets, stands, rod and brackets, kiln fitments, and almirahs.

The Timber Testing Section was supplied with 9,601 specimens and the Wood Technology Section received 613 hand specimens and 26 Gamble specimens.

Various enquiries in connection with woodworking and related subjects other than veneers, plywood and glues were received. Amongst these were the following :—

(*a*) The installation of a factory for the manufacture of hammer handles.

(*b*) Tree felling machinery.

(*c*) Machinery for brush making.

(*d*) Parquet flooring.

(*e*) Manufacture of splints by machinery.

A course of lectures was delivered to the I. F. S. students on, sawmills, wood working and plywood.

2. *Sawmill.*

233 logs were converted as compared with 342 logs converted the previous year. These logs were dealt with on behalf of the Timber Testing, Seasoning and Wood Working Sections.

About 1,500 maunds of timber was prepared for the charcoal experiments of the Minor Forest Products Section, 70 sleepers were converted, 300 crossers made, 4,700 paving blocks prepared, 600 posts converted, and 300 pegs and mallets prepared.

3. *Veneer Sub-Section.*

Several sets of tests on both ordinary and corrugated plywood were carried out on behalf of Messrs Bird and Co., Calcutta. These tests were made with a view to ascertaining whether the introduction of corrugations increased the strength of plywood and if so whether corrugated plywood could be made up with thinner plies. Test results indicated that in the matter of strength there was nothing to choose between the two forms of plywood. In the case of the corrugated plywood, however, the crests of corrugations took more than a fair share of rough usage in the drum box test and were rapidly worn through, which indicates that the same would happen in practical work.

Tests on birch burrs from the Conservator of Forests, Kumaon Circle, were completed and also plywood tests on *Betula alnoides* from Bengal. The latter material behaved very well in the drum box and other tests and, in the matter of strength, should make a good substitute for imported plywood. In addition, *Betula alnoides* made up into excellent tools, boot trees etc., and should make an excellent substitute for foreign birch for most purposes to which this species is put.

Plywood and glue tests were continued on :—

Amoora wallichii.	*Machilus macrantha.*
Betula alnoides.	*Swietenia mahagoni.*
Duabanga sonneratioides.	*Tectona grandis.*
Grevillea robusta.	*Valeria indica.*

Tests were carried out on caseins supplied by Messrs Sen Manufacturing Co., Calcutta, and "Glupol" supplied by Messrs Polson Manufacturing Co., Bombay.

The flush veneer panelling of figured laurel (*Terminalia tomentosa*) in the board room was completed and is now under observation. This panelling has been much admired by everyone who has seen it.

4. *Enquiries received.*

Many enquiries relating to veneers and plywood were received during the year. Amongst the most interesting are the following :—

(*a*) The establishment of factories for the manufacture of plywood in India and in Bombay Presidency.

(*b*) The disposal of casein in India.

(*c*) The suitability of Indian timbers for 3-ply wood for manufacture of tea chests in Ceylon.

(*d*) The most suitable glues for use in India.

(*e*) The establishment of a plywood factory in Bareilly.

(*f*) Plywood for racing boats in Burma.

Minor Forest Products Section.

1. *F. R. I. Portable Charcoal Kiln.*

It was mentioned in last year's report that some of the lower panels of the kiln had a tendency to buckle on account of the intense heat generated in the kiln. To remedy this minor defect, $1\frac{1}{2}''$ angle irons were fitted as stiffeners at the base of the bottom panels instead of the $1''$ angle irons originally fitted. This alteration appears to have had the desired effect as there has been no buckling in subsequent trials.

In order to test the life of the kiln, burnings were carried out in the Institute grounds with material consisting mostly of green mango (*Mangifera indica*) and some other species felled on the estate. The results up to the end of the year were very satisfactory and no defect was noticeable in the kiln after 40 charges had been burnt.

Scale drawings of the kiln have now been made with a view to getting quotations from reliable firms for its manufacture in India.

2. *Charcoal briquetting.*

Further experiments with the small power-driven ovoid briquetting press were made using *Bauhinia retusa* gum and various starchy binders. The best briquettes were obtained with 5 per cent of gum and 4 per cent of powdered rice (cheapest quality bazaar rice was used). The amount of water required seems to vary between 30 and 40 per cent depending on the density of the charcoal used.

Charcoal briquettes prepared with *Bauhinia retusa* gum and starchy binders were found to smoke slightly when first lighted. It was also found that most of the smoke was due to the starchy binders and very

little to the gum. A series of experiments was, therefore, undertaken increasing the amount of gum while reducing the amount of starchy binders used. From these experiments it has been found that satisfactory briquettes could be made using 6 per cent of *Bauhinia retusa* gum only. Such briquettes burn well with practically no smoke. The briquettes prepared using starchy binders only, without any gum, not only give off a lot of smoke but crumble to powder if poked while burning.

3. *Determination of the calorific values of some Indian woods.*

The results of this investigation were published as Forest Bulletin No. 79 during the year.

4. *Minor Forest Products Garden.*

The area at the south end of the garden which up to now had not been cleared, was taken in hand during the year under review, and the ground has been levelled and paths laid out. A number of new exhibits were added to the garden during the year. The *Artemisia maritima* plants grown from seed last year suffered heavy mortality during the monsoon at the close of which only one or two plants were left alive in each bed. These survivors are, however, growing vigorously now. The cause of death was probably the water logging of the soil during the rains, as the soil and the subsoil consist of stiff clay.

To investigate the best conditions for the growth of *Artemisia*, some more seeds were obtained this year and sown in different types of soil on slopes and on level ground. Germination was good in all beds except in those containing a certain amount of lime in the soil.

Paper Pulp Section.

1. *Experimental Factory.*

Owing to the need for economy, the steam boiler was shut down at four different times during the year for a total period of about 19 weeks necessitating suspension of work in the paper mill. The operation of the mill had also to be stopped for another 5 weeks for the re-erection of the pulp-hall walls which had cracked so badly during the rains as to render the building dangerous.

(*a*) *Rod Mill.*—The open end Marcy rod mill, equipped with stainless liners and rods, was erected in the mill and was operated for a short period towards the close of the year under report. It is expected that this mill will be found very serviceable for carrying out pulping experiments on grasses and other short-fibred materials.

(*b*) *Disintegration of bamboos.*—Experiments on the disintegration of bamboos were continued during the year under report. The results obtained were an improvement on those of last year, but the desired end has not yet been achieved. It is proposed to continue the experiments during the current year.

(*c*) *Tests on flowered Dendrocalamus strictus bamboos.*—At the request of H. E. H. The Nizam's Government, pulp and paper making tests were carried out on three kinds of *Dendrocalamus strictus* bamboos *viz.* (1) One year old green bamboos, (2) freshly flowered bamboos and (3) bamboos which had flowered and died about 4 years back but were free from borer and fungus attack. The main object of the tests was to find out if flowered bamboos could be economically converted into easy bleaching pulp and thus serve as a reserve supply for a mill, during the period a flowered bamboo area was regenerating and maturing for exploitation. The tests showed that the flowered bamboos were not only as good a paper making material as unflowered bamboos, but gave a higher percentage yield of cellulose and paper. The digestion treatment required for the flowered bamboos was, however, slightly more drastic than that required for unflowered bamboos, due, apparently, to the former containing a higher percentage of lignin.

(*d*) *Tests on bagasse* (*crushed sugar cane*).—A few trials were made on the production of wrapping papers from bagasse, using the rod mill for beating the pulp. The experiments showed that bagasse pulp, particularly in admixture with some long fibred pulp such as bamboo pulp, can yield fairly satisfactory packing and wrapping papers.

(*e*) *Manufacture of paper.*—About 2½ tons of writing, printing and type papers, and boards were manufactured in the mill and supplied to the Forest Research Institute and College and to the Government of India Press for the printing of Forest Research Institute publications.

2. *Laboratory.*

(*a*) *Preparation of pulp for artificial silk.*—Experiments on the development of an economic and commercial process for the purification of *Melocanna bambusoides* pulp to render it suitable for the manufacture of artificial silk were continued throughout the year and are still in progress. The desired end has not yet been achieved though a suitable pulp has been prepared on a very small scale. The process adopted in this case was, however, of doubtful *commercial* value, and the investigation must be continued.

(*b*) *Pulping tests on bamboos from Bengal.*—Autoclave tests were carried out on the following 5 species of bamboos from Bengal :—

(1) *Dendrocalamus hamiltonii* (*kokwa*),

(2) *Dendrocalamus longispathus* (*orah*),

(3) *Teinostachyum dulloor* (*dolu*),

(4) *Oxytenanthera auriculata* (*kalisari*),

(5) *Bambusa tulda* (*mitenga*).

All five species were found suitable for the manufacture of pulp and paper, either singly or mixed together. Semi-commercial tests on the above species are included in the programme of work for the next triennium.

(*c*) *Analyses of bamboos and grasses.*—Chemical analyses, consisting of the determination of pentosans, lignin, cellulose, ash, etc., were carried out for the following :—

(1) *Ischoemum angustifolium* (*sabai* grass),

(2) *Saccharum spontaneum* (*kans* grass),

(3) *Ochlandra brandisii* (*eta* bamboo),

(4) *Melocanna bambusoides* (*muli* bamboo) and

(5) *Dendrocalamus strictus* (male bamboo), (from Hyderabad State).

(*d*) *Tests on Boswellia serrata* (*salai wood*) *and Eragrostis elegantula* (*bhulwa grass*).—Both materials yielded a very low percentage of pulp which could neither be bleached economically nor converted into satisfactory papers and were, therefore, considered unsuitable for pulp and paper making.

(*e*) *Tests on Eucalyptus globulus* (*Nilgiri blue-gum*).—Autoclave tests by the soda, sulphate, and sulphite processes were carried out on this material. The yield of pulp by all three processes was satisfactory and the pulp also bleached easily. The pulp, however, is short fibred and can be used only in paper manufacture as a filler or in admixture with a long fibred pulp such as rag or bamboo pulp. It is proposed to carry out semi-commercial tests on this material in the future. It will also be interesting to test the material for the manufacture of mechanical or groundwood-pulp.

(*f*) *Softening of water for steam boiler feed.*—Routine analytical work in connection with the softening of the main supply of water for boiler feed was carried out, as and when required, with complete satisfaction.

3. *Lectures.*

The usual course of lectures and practical demonstrations were given by the officer in charge to students of the senior I. F. S. class.

4. *Technical information and advice.*

(*a*) Advice on certain technical points concerning the manufacture of straw-boards was given to Messrs The Straw-Board Manufacturing Co., Ltd., Saharanpur.

(*b*) Mr. K. Nizamuddin, Paper Expert to H. E. H. The Nizam's Government, worked in the section for nearly two months. He was engaged on the investigation on bamboos received from the state.

(*c*) Correspondence was also undertaken with private individuals, commercial firms and government forest and industries departments in connection with 25 enquiries referring to pulp and paper problems.

5. *Bamboo Pulp Projects.*

The Burma bamboo pulp schemes have not materialised as yet, due, it appears, to the general depression prevailing all over the world.

The Commerce and Industries Department of H. E. H. the Nizam's Government carried out a detailed survey of bamboo forest areas in the north eastern districts of the state. A project for the establishment of a paper mill was submitted to the Paper Pulp Expert at the Forest Research Institute for perusal and criticism. The scheme appears to be quite sound and feasible.

The Madras Forest Department have completed the survey of bamboo forests in the Madeswaranmalai Reserved Forests (North Coimbatore and Kollegal Division). It appears that Mettur on the Cauvery is a very favourable site for the establishment of a mill for the manufacture of paper from bamboos from this area.

Mechanical Sub-Section.

This auxiliary sub-section continued to function satisfactorily throughout the year, and all plant and machinery were kept in working order.

In the Seasoning Section, three new blower type kilns were erected in place of the old Sturtevant kilns. One internal fan (reversible circulation) kiln was erected in place of one of the old Tiemann kilns. One small kiln of the type of an internal fan circulation system was erected. Two small constant humidity chambers (fitted with fans for internal circulation) were also erected. Most of the equipment for these kilns was made in the workshops. In the Paper Pulp Section, a rod mill was erected during the year and a number of modifications were made to improve the bamboo disintegrator. A new glue spreading appliance was made for the veneer shop and a number of additions and alterations were made in the wood preservation plant for carrying out experiments under a new method of treatment.

CHAPTER VI.—CHEMISTRY BRANCH.

The following programme of work was undertaken during the year under report :—

1. General study of the chemistry and commercial uses of the minor forest products.

A. Drugs :—

i. *Polygonatum multiflorum.*
ii. *Indian Ephedras.*
iii. *Dodonæa viscosa.*
iv. *Indian Artemisias.*
v. *Strychnos nux-vomica.*
vi. *Senecio* spp.
vii. *Derris* spp.

B. Oils and Fats :—

i. *Vateria indica.*
ii. *Actinodaphne hookeri.*
iii. *Tectona grandis.*
iv. *Aleurites montana* and *A. fordii.*

2. Study of forest soils.

3. Miscellaneous enquiries.

I. A.—Drugs.

(i) *Polygonatum multiflorum* All. syn. *Convallaria polygonatum* Linn.—(Solomon's seal) is a popular remedy, in Europe, for removing bruises and discolouration of skin resulting from blows. This drug has recently been sent from Kashmir as it was of interest to see if it contained the active constituents, the glucoside *convallarin* and *asparagin*, which are found in the European varieties. Asparagin to the extent of about 0·2 per cent has been detected in the sample analysed but not *convallarin*.

(ii) *Ephedras.*—It was reported last year that *E. sinica* had been grown at the Institute from seeds obtained from China and on analysis were found to contain 0·75 per cent of the total alkaloids. Further analyses have been made in the third year of its growth and the results (tabulated below) show 1·1 per cent of the total alkaloids. This com-

pares very favourably with the alkaloidal content in *E. sinica* grown in China—

Date of collection.	Moisture in the air-dried sample.	Total alkaloids.	Total alkaloids in the sample grown in China.
15th September 1931	8·5	0·75	1·12
17th November 1931.	8·5	0·49	Not recorded.
7th June 1932 . .	9·0	1·1	The highest content is reached in early October after which there is a rapid fall.

Ephedra gerardiana was grown in Lahore (Punjab) by Prof. S. R. Kashyap, Professor of Botany in the Punjab University, from seeds obtained from Bashahr hills. A sample of this, collected in October 1932, was analysed and found to contain only 0·04 per cent. of the total alkaloids. Such a low alkaloidal content is surprising. The analysis of the soil on which it had been grown indicated the presence of a very large percentage (8 per cent) of lime. Such a high percentage of lime is, of course, not normal in garden soils in Lahore but appears to be accidental in this particular case and may account for the poor quality of the drug. It is hoped that if *E. gerardiana* were grown on a normal soil it might show much higher alkaloidal content.

A new species of *Ephedra* has been collected from the Upper Indus Valley. In appearance it resembles *E. intermedia* except that the stems are thicker and longer. On analysis it was found to contain 0·77 per cent of total alkaloids, the whole of which was found to be pseudo-ephedrine.

(iii) *Dodonæa viscosa* Linn. is a gregarious shrub, growing plentifully in the drier regions of the North-West and Central India and is very commonly grown as a hedge plant since it is not browsed by cattle. The natural aversion of animals to this plant suggested in it the presence of some constituents distasteful to them and it was thought that the very same constituents might possess some medicinal properties. In books on Indian medicinal plants it is mentioned that the leaves of *D. viscosa* when applied over a wound will heal it without leaving a white scar. It is also said to possess febrifuge properties. Since no information was available about the chemistry of this plant, it was thought desirable to investigate it with a view to finding some constituents of economic value, medicinal or otherwise. Chemical examination appears to indicate that the medicinal properties might be due to an alkaloid (0·02 per cent) and to the small amount of a glucoside which

the leaves have been found to contain. Both the alkaloid and the glucoside have not yet been identified. The leaves also contain a fair amount (10-15 per cent) of a neutral and an acidic resin and some amorphous bodies. The leaves and the bark contain tannins but appear to be of no value as tanning materials. Results of the preliminary examination have been published in *The Indian Forester* 1933, p. 78.

(iv) *Indian Artemisias.*—During the past few years *Artemisias* have attracted considerable attention, particularly the Indian species which, it was thought, would serve as an additional source of supply of the valuable anthelmintic santonin, monopoly for the supply of which had, hitherto, been held by Russian Turkestan. In India many species of *Artemisia* are found but it is only the *A. maritima*, Linn. (*A. brevifolia*, Wall), which grows abundantly in Kashmir, Kumaon and the North-West Frontier Province, that has so far been found to yield any santonin, as is evident from the findings of Simonsen (*Jour. Ind. & Labour 1921*, 539) and of Greenish and Pearson (*Pharm. Journal 106*, 2). Their observations and results established definitely the fact that Indian *Artemisia* contains santonin even though the santonin content is not as high as in the Russian species. Recent work on Kashmir *Artemisias* has, on the other hand, shown that in many cases a yield of over two per cent of santonin can be obtained and these figures are quite as high as those obtained from the Russian species. The richest sample from the Kurram Valley (North-West Frontier Province) has given over 1·7 per cent of santonin, but the yield is not so uniformly high in all *Artemisias* found in the Kurram Valley. It is only in certain areas that *A. maritima* rich in santonin is found while in others a santonin-free variety grows, even though these areas are only a couple of miles apart. No botanical distinction has yet been made of these two varieties and, therefore, in the field it is not possible to distinguish the richer variety. This fact is not peculiar to the Indian *Artemisias* alone but finds a parallel in the "two' English varieties of *A. maritima*, var. *anglica* with drooping flowering branches containing no santonin while var. *gallica* with erect branches does contain it." (Chemist and Druggist, 1929, p. 726.) Similarly in Russian Turkestan there is another variety of *A. cina* which contains practically no santonin and is, therefore, used in adulterating the richer varieties.

Since no botanical differentiation has, hitherto, been made in these forms or varieties, it was thought that soil analyses might show certain characteristics upon which the differentiation might be based. This view was further strengthened since a comparison of the climatic and the topographical conditions in which *A. maritima* grows and flourishes did not reveal any correlation between their santonin content. It is well known that difference in habitat frequently alters the chemical

constituents of a plant but this does not appear to be strictly true in the case of *A. maritima*. For example, there appears to be nothing in common in the habitat of the variety growing in Scotland and those growing in the Kurram Valley and yet both of them yield fair quantities of santonin. The Indian variety of *A. maritima*. Linn. (*A. brevifolia*, Wall) is found in the Himalayas at 4,000—12,000 ft. as far east as Garhwal, but more or less confined to the inner dry valleys to which the monsoon does not penetrate. The Scottish variety on the other hand, "grows on the east coast of Scotland. The sea-shore, where the plant was found is apparently very different from the dry, rocky mountainous regions productive of the foreign variety, but it is essentially the same in favouring the development of strongly xerophytic plants, such as *Artemisia*. It is similar to that large belt of Russia where the plant is so prolific, in being very saline and indeed at high tide is completely covered with sea-water". (J. Coutts, *Pharm. Jour. and Pharmacist 1929*, p. 603.)

The general characteristics that appear to have an influence on the growth of *A. maritima* are, the character of the soil, whether clayey or sandy, the salt content and the temperature in winter. In the Kurram Valley it has been observed that *A. maritima* growing on the ridges of cultivated fields always gave a higher yield of santonin than plants growing on uncultivated land. This together with the above observations led to examination of the soils of the various *Artemisia*-growing areas. The results given in the following table show nothing decisive, but they appear to indicate in a general way that higher content of available potash and a higher proportion of silt and fine sand are met with in the soils of the area in the Kurram Valley where *A. maritima* rich in santonin grows.

Soils of the Kurram Valley.

Area.	Depth.	Fine stone and gravel.	Coarse sand.	Fine sand.	Silt.	Clay.	Hygroscopic moisture.	Organic matter.	Available potash K_2O.	Available *phosphate* P_2O_5.	REMARKS.
Mallikhel	0"-6"	6·7	22·3	31·0	31·4	8·6	1·85	3·05	0·011	0·001	*Artemisia maritima* growing in this locality is santonin free.
	6"-18"	8·1	10·6	25·8	39·1	16·4	2·21	4·51	0·011	0·001	
Nastikot	0"-6"	0·9	22·3	38·2	30·3	8·3	0·76	1·41	..	0·001	Poor quality. Average santonin content is about 0·5 per cent.
	6"-18"	0·8	19·4	33·8	33·9	12·1	0·95	3·07	..	0·001	
Burki (wild area)	0"-6"	*Nil*	16·2	60·9	19·6	3·3	0·45	6·09	0·033	0·001	Good quality. *Artemisia maritima* grows in this locality. Average santonin content is over 1·2 per cent.
	6"-18"	*Nil*	6·9	35·5	46·7	10·9	1·07	6·02	0·045	0·001	
„ (ridges)	0"-6"	*Nil*	10·1	45·3	37·2	7·3	0·85	7·19	0·045	0·02	Average santonin content is 1·5 per cent.
„ (cultivated areas)	0"-6"	*Nil*	1·0	19·4	66·3	13·3	1·38	0·25	0·045	0·04	Ditto.

The wide differences in the santonin content could not be explained on the inconclusive results obtained from the soil analyses and this, therefore, suggested a careful search for certain botanical characteristics. Mr. R. L. Badhwar, late of the Botanical Survey of India, carried out the botanical survey of the *Artemisias* of the Kurram Valley and he observed that in certain areas the young plants had red stems while others had the usual green, but in both of these the colour changed to brown on maturity when the distinction in colour was lost. On chemical examination it was found that the red stemmed form always gave a high yield of santonin while the green stemmed *Artemisias* were santonin-free. Hence the santonin-rich form of *A. maritima* has been designated as *A. maritima* forma *rubricaule*. The seasonal variation of santonin in the *A. maritima* forma *rubricaule* has already been reported last year.

It was reported last year that successful attempts had been made to grow *A. maritima* from seeds obtained from Kurram Valley. The seeds were sown in February 1931 and these germinated in about 4—6 weeks. In April some of the young plants were transplanted in beds where they kept in good condition till June when slight withering due to excessive heat was observed. The plants were still tender at this stage and, therefore, no attempt was made to collect a sample for analysis. Two months later, however, during the monsoon a sample was collected and was found to contain 0·85 per cent of santonin. During the rains the plants suffered from water-logging, but they survived with only a few casualties. These were left untouched during the following autumn and winter; and early in spring of 1932 fresh leaves made their appearance. In April the growth was fairly vigorous and a sample was collected and analysed when 1·3 per cent. of santonin was found.

The form of *Artemisia* grown at Dehra Dun divided itself in two sub-forms designated in the table as the x-form and the y-form, the only distinction between the two being that the x-form produced the flowerheads early in June while the y-form showed no flower-buds till mid August. From the general nature of the plant it appears that the y-form is the original *A. maritima* forma *rubricaule* and the x-form is only the acclimatised form of y. In the x-form, therefore, the maturity is earlier and the santonin content highest during the period preceding the monsoon.

Date of collection.	Santonin in x-form.	Remarks.	Santonin in y-form.	Remarks.
	Per cent		Per cent.	
1st May 1932 . . .	1·35	No buds . .	..	
4th June 1932 . . .	1·35	Young buds . .	1·07	Luxuriant growth but no buds.
1st July 1932 . . .	1·48	Advanced stage of buds.	..	
		Rains commenced ,	..	Monsoon started.
18th July 1932 . .	1·02	Ditto ,	0·66	No buds.
13th August 1932 . .	0·72	Yellow buds still unopened.	0·38	Ditto.
1st September 1932 . .	0·43	Plants withering ,	0·26	Young buds appearing but plants withering.

The soil on which the above sample of *A. maritima* had been grown gave the following characteristics :—

Depth.	Coarse sand.	Fine sand.	Silt.	Clay.	Hygroscopic moisture.	Organic matter.	Available potash (K_2O)	Available phosphate (P_2O_5)
0"-6"	17·4	38·2	31·4	13·0	1·06	4·76	0·024	0 04
6"-18"	18·6	34·2	29 8	17·4	1·51	4·83	0·028	0·051

These results have been published in the *Quarterly Journal of Pharmacy and Pharmacology*, Vol. VI, No. 1, 1933.

(v) *Strychnos nux-vomica.*—It was reported by one of the exporters of *Strychnos nux-vomica* that the seeds as now exported from India no longer contained the same percentage of strychnine as in previous years. This conclusion they had based on the complaints received from their various purchasers in different parts of the world, who in recent years had noticed a marked deterioration of the alkaloidal content of *S. nux-vomica*. Since the method of preparing the nuts for shipment and the outward appearance of the goods shipped had remained unaltered, the true explanation of the cause remained a puzzle.

In course of a search for the probable causes, it was discovered that at some places the seeds are washed in water before they are brought on the market and in an insufficiently dried condition are stored at seaports in damp places, sometimes for a fairly long period before actual shipment. This suggested that the cause of deterioration might possibly be due to biochemical changes during storage in a damp condition. It might also be due to the seasonal variation, since the collection of the seeds either from the trees or from the ground is dependent on the availability of local labour and on other conditions and factors. In order to confirm the above suggestions the following experiments were planned and conducted :—

(1) *Storage experiments.*

(*a*) In dry condition.

(*b*) In damp condition over water and exposed to the atmosphere.

(*c*) Over water but not exposed to the atmosphere.

(*d*) Storage in laboratory and exposed to the atmosphere.

(2) *Seasonal variation.*

The results obtained indicate that there is hardly any deterioration of the alkaloidal content under the conditions of the experiments given above. The seeds that had been stored over water, no doubt, lost their original brightness and got covered with a surface layer of mould but the alkaloidal content remained almost unaltered during the period of about fifteen months, as is evident both from the chemical and the mycological examination of the nuts. The seeds that were heavily coated with mould were selected for analysis and the results obtained are given below :—

	Total alkaloids per cent.	Strychnine per cent.
Mouldy buttons (from West Coast collections) .	1·9	1·0
Average alkaloidal content for West Coast seeds .	2·0	1·0

It is recorded in the literature (*Chem. and Drug.*, 1928, *108*, 296) that nux-vomica seeds with the most silky appearance yield the largest amount of alkaloids and it is a fact that old crop seeds which have been subject to long storage gradually lose the original silky appearance. From this it would appear that the loss of the silky appearance is indicative of the loss in the alkaloidal content. The literature also records that strychnine is chiefly contained in the inner portion of the seed and brucine chiefly in the outer layers. These observations appeared interesting and, therefore, have now been reinvestigated but the results recorded in the present communication do not confirm the views cited above. The silky coating forms nearly 20 per cent. of the total seed weight and can easily be peeled off after the seeds have been boiled in water for a few hours. The following table shows the proportion of strychnine in the total alkaloids, both in the silky and in the horny portion of the seed.

	Total alkaloids (per cent).	Strychnine (per cent).	Brucine : strychnine (ratio).	
Seed as a whole	2·55	1·23	52	48
Silky coat	1·83	1·04	43	57
Horny portion	2·73	1·28	53	47

The samples that have now been examined contained the usual amounts of the total alkaloids as well as strychnine and the effect of seasonal variation and of storage on the alkaloidal content is of no practical significance. The explanation for the lower alkaloidal content had, therefore, to be sought elsewhere. The most probable one appears to be the adulteration with other species of *Strychnos* whose seeds closely resemble those of *S. nux-vomica*, but which contain very little or no alkaloid. The seeds of the Burmese species of *S. nux-blanda*, for example, are similar to those of the Indian *S. nux-vomica* but contain no strychnine whatever and have no bitterness (Small, Pharm. J. 1913, 90, 510). For a long time the Burmese species were confused with *S. nux-vomica*, but it is only recently that it has been botanically characterised as distinct (Hill, *Kew Bulletin*, 1917, Nos. 4 and 5, 121). Similarly are the seeds of *S. potatorum*, Linn., growing in the Deccan Peninsula, devoid of the poisonous properties. *Pharmacographia indica* (Vol. II, 507) mentions the seeds as yielding a bitter extract which principally contains brucine and no trace of strychnine.

The seeds of other Indian species of *Strychnos*, namely *S. rheedei*, Clarke, *S. cinnamomifolia*, Thw. and *S. colubrina*, Linn., have varying strychnine contents and their presence in commercial samples may account for the lower alkaloidal content of the drug.

The experimental results are recorded below :—

Strychnos nux-vomica seeds obtained from Sriharikota Range, Nellore District, Madras Presidency (East Coast) contained 8 per cent moisture 2·75 per cent of total alkaloids and 1·2 per cent of strychnine.

Months.	Storage over sulphuric acid.		Storage over water.		Storage over water and exposed to atmosphere.		Storage in laboratory and exposed to atmosphere.	
	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
June	2·60	1·20	2·55	1·30	..	..	2·65	1·25
July	2·75	1·30	2·55	1·30	2·75	1·25	2·60	1·20
August	2·75	1·25	2·50	1·20	2·45	1·20	..	1·25
September	2·70	1·30	..	1·30	..	1·15	2·55	1·25
October	2·75	1·30	2·55	1·25	2·40	1·15	2·55	1·20
November	2·50	..	..	1·25	2·35	1·20	2·50	1·20

Strychnos nux-vomica seeds obtained from Beltangady Range, South Mangalore District, Madras Presidency (West Coast), contained 9 per cent moisture, 2·2 per cent total alkaloids and 1·1 per cent strychnine.

Months.	Storage over sulphuric acid.		Storage over water.		Storage over water and exposed to atmosphere		Storage in laboratory and exposed to atmosphere.	
	Total alkaloids	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.
	Per cent	Per cent.	Per cent.	Per cent.	Per cent	Per cent	Per cent.	Per cent.
June	2 20	1·10	2·05	1·05	..	..	2·00	1·00
July	2 00	1·00	2·15	1·00	..	..	1·95	1·05
August . . .	2·20	1·10	2·05	1·00	2·10	1 05	1·90	1·05
September . . .	1·95	0·95	..	0·95	1·90	1·15	..	0·95
October . . .	1·95	1·05	1·90	1·00	1·75	1·15	1·90	1·00
November . . .	1·90	0 95	1·95	1·00	1·50	..	..	..
December . . .	1·95	1·10	1·95	0 95	..	..	1·95	0 95

Seasonal Variation (East Coast).

	Fruits from trees.		Fruits and seeds from ground.	
	Total alkaloids.	Strychnine.	Total alkaloids.	Strychnine.
	Per cent.	Per cent.	Per cent.	Per cent.
December	2·75	1·15	..	1·25
January	2·65	1·15	2·75	1·25
February	2·65	1·05	2·60	1·25
March	2·45	1·00	2·65	1·20
April	2·45	1·15	2·45	1·25

Mycological examination of the buttons was conducted by Dr. K. D. Bagchee, Mycologist at the Forest Research Institute, whose report is as follows :—Twelve buttons were examined from each lot, selection being made from those which appeared dirty, dull or abnormal coloured and suspected of fungus infection. Mycological examination showed that the fungal attack was noticed only on the seeds that had been stored over water and exposed to the atmosphere, and in these cases too the fungal attack had only been on the outside silky coat and had not penetrated into the horny portion of the button. Even in those cases where the fungal attack had been most vigorous the alkaloidal content had not varied. (These results have been published in the *Quarterly Journal of Pharmacy and Pharmacology*, Vol. V, No. 4, 1932, pp. 633-638.)

It may be interesting to mention that *S. nux-vomica* forms one of the important minor forest products of India and large quantities of it are collected both for export and consumption in the country. One of the chemical manufacturers in India has recently extended their plant to extract 1,000 mds. of *S. nux-vomica* seeds per month.

(vi) *Senecio chrysanthemoides.*—A number of European and African species of *Senecio* are already known to possess alkaloidal bodies, many of which are toxic, particularly to cattle. The Indian species, on the other hand, have hitherto not attracted any attention, consequently very little is known about their chemical composition or physiological action. Preliminary examination of *S. chrysanthemoides* obtained from Kashmir showed the presence of alkaloids (about 0·10 per cent) and inulin. From the total two definite alkaloids have been isolated one m.p. 225-26°C and the other m.p. 120° (soluble in water, very soluble in chloroform and sparingly soluble in ether). While this work was in progress, Manske published a paper on "The alkaloids of *Senecio* spp.": (*Canadian Journal of Research* 1931, 5, 651) and reported the isolation of jacobine (m.p. 223-24°C) an alkaloid from *S. jacobea.* A sample of jacobine was obtained from Dr. Manske and it helped to establish the identity of one of the alkaloids (m.p. 225—26°C) from *S. chrysanthemoides* and this was found to be identical with jacobine. Attempts are being made to establish the identity of the second alkaloid (m.p. 120°C) work on which is still in progress.

(vii) *Derris* spp.—In a note by the Deputy Trade Commissioner for India in London (*The Indian Forester*, 1933, p. 462) it was pointed out that trade with European markets in *Derris* root could be established if suitable varieties of *Derris* containing reasonably high content of rotenone were available. The Indian species of *Derris* do not appear to have been fully investigated and only casual references have been made to *D. uliginosa* and *D. malaccensis.* These have been reported not to contain any rotenone which is the active principle of *Derris* roots and yet these enjoy a fair reputation in India as fish poisons. The present enquiry was, therefore, instituted at the suggestion of the Agricultural Expert with the Government of India and of the Inspector General of Forests. Of all the species of *Derris* known, *D. elliptica* is the one that has been found to contain the highest content of rotenone. This species,* however, does not appear to occur anywhere in India proper; *D. uliginosa* on the other hand, is indigenous in certain parts of the country but has not shown any rotenone content even though it enjoys a reputation as an insecticide. This leads one to believe that the insecticidal value of *D. uliginosa* might possibly be due to sub-

* Since this had been written information was received about the occurrence of *D. elliptica* in certain parts of Assam. A sample from Dibrugarh was found to contain about 1 per cent of rotenone.

stances other than rotenone. A sample of *D. uliginosa* obtained from the Sunderbans Division, Bengal, gave the following results:—

Constituents.	Roots.	Stems.	Remarks.
	Per cent.	Per cent.	
Moisture . . .	3·7	7·2	
Ash	3·4	4·4	The ash contained a very large proportion of sodium chloride.
Ether extract . .	1·9	1·07	In case of *D. elliptica* it is reported to be 7·22 per cent.
Chloroform extract .	..	0·15	
Alcohol extract . .	5·9	2·0	
Methoxyl content of the ether extract.	4·3	..	In case of *D. elliptica* it is reported to be 13·5—14·7 per cent.

The low percentage of the extractable matter with ether and its methoxyl content indicated a very low percentage of rotenone which in actual experiments it was never possible to isolate. The presence of toxicarol and digueline in the ether extract was also not detected. This work is still in progress and it is intended to examine the drug periodically to study the seasonal variation. Meanwhile powdered roots and stems and an alcoholic extract of the roots have been sent to the Forest Entomologist for biological assay.

1. B.—Oils and Fats.

(i) *Vateria indica.*—When the work on this fat was ready for publication, a paper on the same subject appeared in the *Journal of the Society of Chemical Industry* (1931, 50, 471T) wherein Miss Jones had shown the fatty acids to consist of palmitic, stearic, arachidic and oleic acids. Since these results were not quite in accordance with those obtained here, it was considered desirable to withhold the publication and to re-check the data. The results obtained now appear to indicate the presence of myristic, stearic, lignoceric, isomeric oleic and oleic acids in the total acids from the fat, and a careful search for palmitic and arachidic acid did not reveal their presence. The slight differences in the results that were reported last year and those obtained now was due to the difficulty of complete separation of the unsaturated solid acids from the liquid acids. This separation has now been effected more satisfactorily and the component fatty acids are found to be myristic acid 1·2 per cent, stearic acid 58·8 per cent, lignoceric acid 0·6 per cent, and oleic plus isomeric oleic acids 39·4 per cent.

(ii) *Actinodaphne hookeri.*—The physical and chemical constants for the fat from the seeds were reported last year. Further examination shows the fat to consist of the glycerides of lauric acid (96 per cent) and oleic acid (4 per cent). A single crystallisation from alcohol removed the small amount of the liquid oil and trilaurin of iodine value zero was obtained. The fat from these seeds, therefore, appears to be an excellent source of obtaining pure lauric acid.

Pericarp on the kernels also yielded an oil which on cooling and 'chilling' deposited some trilaurin. The residual oil gave the following constants for the mixed acids.

Mean molecular weight	265
Iodine value	54·8
Saturated acids	33·0 per cent.
Unsaturated acids	55·8 „
Resin acids	11·2 „

(iii) *Tectona grandis.*—It is commonly stated in works on Indian forestry that teak wood contains an oil which possesses antiseptic properties and is present in such abundance that it could be used as a substitute for linseed oil in paints and varnishes. Chemical examination, on the other hand, indicates that seasoned teak wood contains neither an essential oil nor a fatty oil. The seeds, however, yield an oil but appear to contain no such constituent that could render teak wood immune from white-ant attacks. The seeds yield no essential oil but only an insignificant amount of a white flocculent matter.

The seeds gave 0·6 per cent of the kernels. The kernels when extracted with petroleum ether yielded 40·9 per cent of a bright red oil of the following general characteristics :—

Specific gravity at 20°C.	0·9213
Refractive Index at 25°C.	1·4055
Iodine value	107·5
Saponification value	194·5
Hehner value	93·2
Acid value	31·7
Acetyl value	116·1
Unsaponifiable matter	1·25 per cent.

The mixed fatty acids have the following chemical constants :—

Mean molecular weight	278·0
Iodine value	109·0
Saturated acids	25 per cent.
Unsaturated acids	70 „ „
Resin acids	5 „ „

A preliminary study of the mixed acids indicate that the oil consists of the glycerides of palmitic, stearic, oleic and linoleic acids, and a small amount of resin acids.

(iv) *Aleurites montana* and *A. fordii*.—Several samples have been examined during the year with a view to determining the oil content of the seeds collected from plantations in different localities. The tree, which is of Chinese origin appears to grow very well in certain parts of India and the oil content compares favourably with that obtained from the Chinese seeds. The following table gives the comparative figures:—

—	*A. fordii* from Kurseong.	*A. fordii* from Dehra Dun (Bull. Imp. Inst. 273, 1932).	*A. fordii* from Southern Shan States Division	*A. fordii* Chinese origin (Bull. Imp. Inst. 268, 1930)	*A. montana* from Kurseong Division.	*A. montana* of Chinese origin (Bull. Imp. Inst. 270, 1930)
Kernels	61·5	45 21	61·0	54	60	52·5
Moisture	19 0	5·0	4·2	4·5	10·1	5·9
Oil content on dry basis .	41·3	51·6	48·5	58 5	52·5	59 8

2. *Forest Soils.*

It was reported last year that data was being collected on the changes in the properties of soil as it passed from cultivated agricultural land to forest land. The agricultural land of 1927 is now covered over with a young forest which has been divided into four areas namely, the *chir* (*Pinus longifolia*), the *shisham* (*Dalbergia sissoo*), the teak (*Tectona grandis*) and the *sal* (*Shorea robusta*). It is not possible to draw any definite conclusions from the data hitherto obtained and further data extending over another 15 years will have to be collected to form some definite conclusions. Nevertheless, the present data appear to indicate that the soil has not undergone any change in its physical character during the past 5 years. Chemical analyses show that nitrates are now found in greater concentration in the first 3″ especially in the teak and the *shisham* areas and that the amount of organic nitrogen in the *sal* and the *chir* areas has fallen since 1927. The organic matter also is lower in all the areas except in the *shisham* where a slight increase is noticeable. The top surface of the soil which was compact during the agricultural period has now become porous but at depths of 18″ and below no change has occurred. These results are evident from the tables given below.

Average figures for samples taken in the month of March 1932 from the four corners of the same area, corresponding figures for March 1927 are given in brackets.

Depth.	Volumetric Composition				Nitrates.	Organic nitrogen (Kjeldahl).	Organic matter	Moisture.
	Water.	Air.	Water and air.	Soil.				
	Per cent.	Per cent	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
				Sal Area.				
0"-3"	17·1	32·7	40 8	50 2	·00016	·071	3·15	13·26
	(24·7	23·1	47·8	52 2	·00011	·132	3 69	17 50)
3"-9"	18 6	27·4	46·0	54 0	·00000	·064	3·45	13·05
	(31·1	12·2	43·3	56 7	·00006	·090	4·13	20·34)
9"-18"	25 0	28·2	53·2	46 8	·00000	071	4·60	22·43
	(37·6	13·1	50 7	49·3	·00006	·116	5·19	28·28)
18"-36"	25·6	27·5	53·1	46·9	·00009	·060	4·65	25·90
	(35·2	21·2	56 4	43·6	·00006	·102	5 90	20 87)
				Char Area.				
0"-3"	14·7	32·6	47·3	52·7	·00017	·093	4·31	10·73
	(20·3	16 3	45·6	54·4	·00011	·118	4·69	10 98)
3"-9"	19 2	26·1	45 3	54·7	·00007	·074	3·97	13·45
	(32 5	4·1	36·6	63·4	·00009	·093	4·66	19·33)
9"-18"	27·9	23·4	51·3	48 7	00007	·081	5·24	21·39
	(35·4	7·3	42 7	57 3	·00009	·099	4·01	22·85)
18"-36"	29·8	23·0	52 8	47·2	00006	072	5·11	23·50
	(30·9	14 9	51·8	48 2	·00009	·093	5·01	28 36)
				Teak Area.				
0"-3"	6·4	39·8	46·2	53 8	·00030	·082	3·88	4·50
	(25·5	20 2	45·7	54·3	·00008	·087	4·12	17·37)
3"-9"	14·2	34·8	49·0	51·0	·00013	·069	4·20	10·88
	(29·1	8·5	37·6	62·4	·00008	·072	4·75	17·37)
9"-18"	19 7	33·7	53·4	46·6	·00009	·073	4·07	16·44
	(29·8	14·8	44·6	55 4	·00008	·075	5·01	19·00)
18"-36"	10 8	33·0	52·8	47·2	·00008	·060	4·72	18·90
	(25·5	20 1	51·6	48·4	·00008	·069	4·09	19·47)
				Shisham Area				
0"-3"	12·5	38·1	50·6	49·4	·00044	·073	3·91	9·96
	(7·4	38·9	46·3	53·7	·00010	·083	3·36	4·98)
3"-9"	14·5	35·8	50 3	49·7	·00017	·068	4·33	11·75
	(23·2	20·2	43·4	56·6	·00008	·064	4·30	15·23)
9"-18"	10·4	34·2	53·6	46·4	·00013	·077	5·30	17·57
	(26·4	25·0	51·4	48·6	·00013	·081	4·92	22·10)
18"-36"	19·3	32·7	52·0	48·0	·00010	·065	5·22	21·79
	(21·0	23·0	44·0	55·1	·00013	·054	3·88	14·46)

Mechanical analysis of the composite samples; corresponding figures for 1927 are given in brackets.

	Sal area				*Chir* area.				Teak area.				*Shisham* area			
	0"-3"	3"-9"	9"-18"	18"-36"	0"-3"	3"-9"	9"-18"	18"-36"	0"-3"	3"-9"	9"-18"	18"-36"	0"-3"	3"-9"	9"-18"	18"-36"
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent	Per cent.	Per cent	Per cent	Per cent	Per cent.	Per cent.	Per cent	Per cent.	Per cent	Per cent.	Per cent.
Coarse sand	34·3	28·2	21·0	25·6	16 9	15 3	9 0	8·7	29·2	27·5	23 7	23 1	31·5	30 9	23·7	23 6
	(33·9	31·2	23·0	23 9	14·8	14·1	10 9	9 0	20·5	25·5	25 3	28 0	36 8	32 6	28 0	26 1)
Fine sand	20·4	20·5	23·0	22 9	22·3	23·5	23·4	23 6	24 0	21·0	20 0	22·1	22 0	20 1	18·2	18·3
	(25·3	25 2	20 2	22·1	22·3	21·4	21·4	24·1	23·1	21·7	19·9	20 6	21·5	20 1	16·9	16·1)
Silt	16·0	16·0	19·2	17·3	28 0	27·2	21·0	25·3	21·6	20 0	17·2	18 6	21·2	19 8	17·9	17 5
	(19·5	17·9	21·1	20·5	30·1	29 1	28 1	27·8	22·1	18 8	18 9	17 0	20 9	22·1	20 2	19·1)
Fine silt	13·6	19 2	26·7	25·5	25·9	26·4	31·4	29·1	18 5	21·1	26·7	25·6	17·1	19 0	27·2	27·9
	(15·0	16 8	20 8	20 9	22·7	24·4	27 6	27·3	17 2	22·8	21·6	22·3	11 6	18·6	25·0	26·1)
Clay	6·7	9·2	11·1	8·7	6·0	7 6	14·3	11 0	6·7	8 6	12 4	11·2	5 2	9 3	13 1	12·7
	(6 3	8·0	14·0	12·3	10·1	11·0	12 0	11·2	7·8	11·2	11·3	12·1	6·2	6·6	9 9	12·0)

3. *Miscellaneous enquiries.*

Composition for reconditioning abrased spike holes.—Reports on the sleepers that were treated with "Fridera" in 1931 have been satisfactory and this has led to further trials for which the Indian State Railways have been supplied with about 10,000 pounds of the material which it is hoped would be sufficient for about 60,000 spike holes. The following remarks of the Chairman of the Seventh Annual Meeting of the Sleeper Pool Committee held in New Delhi in November 1932 may be quoted "I notice that my predecessor referred in 1930 to a composition for filling spike holes in sleepers to prevent 'spike-killing.' This composition has now been patented in many parts of the world by the inventor, under the name of 'Fridera.' The trials in the line have so far proved satisfactory, the composition having survived two hot weathers in the Punjab. Orders for about 5 tons have been received from most of the Indian Railways, and arrangements for manufacture on a commercial scale by the Jallo Subsidiary Industries Co. at Jallo, in the Punjab have been concluded by the inventor."

A large number of analyses of various substances were undertaken on behalf of the officers of the Institute and forest officers. Particular mention may be made of the following:—

Casein cements, glues, essential oils, tannins, *katha*, soils, drugs, etc.

4. *Publications.*

See Appendix I.

APPENDIX I.

PUBLICATIONS OF 1932-33.

Serial No.	Title of Publication.	Author.
	FOREST RECORDS.	
1	Immature Stages of Indian Coleoptera (10) (Anthribidae). April 1932.	J. C. M. Gardner.
2	Treatment of *Babul* (*Acacia arabica*) in Berar. May 1932.	S. A. Vahid.
3	Entomological Investigations on the Spike Disease of Sandal (*Santalum album*)—Part I.—An Introductory Survey of the Problem. August 1932.	C. Dover.
4	Immature Stages of Indian Coleoptera (11) (Platypodidae). October 1932.	J. C. M. Gardner.
5	The Sutlej Deodar.—Its Ecology and Timber Production. January 1933.	R. M. Gorrie.
6	Provisional Volume Tables and Diameter Growth Curve for *Semal* (*Bombax malabaricum*) in the Central Provinces. November 1932.	I. D. Mahendru.
7	Branch Smallwood Tables for *Shorea robusta*, *Tectona grandis*, *Pinus excelsa* and *P. longifolia*. December 1932.	....
8	New Cerambycidae from India (Coleoptera). January 1933	W. S. Fisher.
9	The Importance of the Origin of Seed used in Forestry. January 1933.	H. G. Champion.
10	Provisional Volume Tables and Diameter Growth Curves for *Holoptelea integrifolia* (*Panju*) and *Trewia nudiflora* (*gutel*). February 1933.	I. D. Mahendru.
11	Interim Report on Work under Project No. 2, Strength Tests of Timbers in Structural Sizes. June 1933.	L. N. Seaman.
12	Immature Stages of Indian Coleoptera (12) (Carabidae). June 1933.	J. C. M. Gardner.
13	Immature Stages of Indian Coleoptera (13) (Bostrychidae). August 1933.	Do.
14	Multiple Yield Tables for Deodar. In Press . .	H. G. Champion and I. D. Mahendru.
15	Third Interim Report on Project No. 1.—The Physical and Mechanical Properties of Woods Grown in India. In Press.	V. D. Limaye.
16	Entomological Investigations on the Spike Disease of Sandal (2)—(Scolytidae and Bostrychidae). August 1933.	C. F. C. Beeson.
17	Do. (3)—(Membracidae). July 1933.	W. D. Funkhouser.
18	Do. (4)—(Cercopidae). July 1933.	V. Lallemand.
19	Do. (5)—(Brenthidae and Lyctidae). July 1933.	R. Kleine.
20	Do. (6)—(Anthribidae). July 1933.	Karl Jordan.
21	Do. (7)—The Genus Exocentrus, Cerambycidae. July 1933.	W. S. Fisher.

APPENDIX I—*contd.*

Serial No.	Title of Publication.	Author.
22	Entomological Investigations on the Spike Disease of Sandal (8)—(Cicadidae). In Press.	H. E. Andrewes.
23	Do. (9)—(Neuroptera). July 1933.	Nathan Banks.
24	Do. (10)—(Melasidae and Elatridae). August 1933.	E. Fleutiaux.
25	Do. (11)—(Fulgoridae). In Press.	N. C. Chatterjee.
26	Investigations on the infestation of *Peridermium himalayense* on *Pinus longifolia*, Part II. In Press.	K. Bagchee.
	FOREST BULLETINS.	
27	Identification of Important Indian Sleeper Woods. September 1932.	K. A. Chowdhury.
28	The Problem of the Pure Teak Plantation. October 1932.	H. G. Champion.
29	Calorific Values of some Indian Woods. October 1932	S. Krishna and S. Ramaswami.
30	List of Trees and Shrubs for the Kashmir and Jammu Forest Circles, Jammu and Kashmir State. March 1933.	W. J. Lambert.
31	Testing and Selection of Commercial Wood Preservatives. In Press.	S. Kamesam.
	OTHER PUBLICATIONS.	
32	Progress Report of Forest Research Work in India, for 1930-31. June 1932.	....
33	The Progress of Forest Research in India, 1931-32—Part I.—The Forest Research Institute. September 1932.	....
34	The Progress of Forest Research in India, 1931-32—Part II.—Forest Research in the Provinces. February 1933.	....
35	List of Seeds offered in Exchange, Botanist's Branch. November 1932.	....
36	Annual Return of Statistics relating to Forest Administration in British India for 1931-32. July 1933.	....
37	Guide to the Forest Research Institute. In Press	....
38	Triennial Programme of Research Work 1933-36. August 1933.	....

CONTRIBUTIONS TO SCIENTIFIC PERIODICALS.

Silviculture.

Champion, H. G. . . Note on dying off of *Gmelina arborea* in plantations. (*Indian Forester*, February 1932.)

Champion, H. G. . . Mode of growth of *Alstonia scholaris*. (*Indian Forester*. March 1932.)

Champion, H. G. . . European silvicultural research, Parts I to V. (*Indian Forester*, October 1932 to March 1933.)

Gourlie, R. M. . . The practical use of ecology. (*Indian Forester*, December 1932.)

Gourlie, R. M. . . The better utilisation of forests for grazing. (*Indian Forester*, March 1933.)

Deogún, P. N. . . Nursery manuring experiments. (*Indian Forester*, May 1933.)

Botany.

Parker, R. N. . . . A Burmese climbing bamboo. (*Indian Forester*, January 1932.)

Raizada, M. B. . . New Indian species of forest importance, Part 8. (*Indian Forester*, March 1932.)

Parker, R. N. . . . Casuarina root nodules. (*Indian Forester*, April 1932.)

Parker, R. N. . . . *Cryptocaria amygdalina* and *floribunda*. (*Indian Forester*, August 1932.)

Parker, R. N. . . . The genus *Cymbopogon* in N. W. India. (*Indian Forester*, December 1932.)

Parker, R. N . . . *Vitis rugosa* Wall and *Vitis* spp. (*Indian Forester*, February 1933.)

Entomology.

Appana, M., Chatterjee, N. C., and Dover, C. Investigations on the spike-disease of sandal. Reports VI and VII, 1933. The Bangalore Press, Bangalore City.

Beeson, C. F. C. . . *Lyctus* beetles in India. (*Indian Forester*, Vol. LIX, 1933, pp. 158-164.)

Bhatia, B. M. . . An effective method of disposing of rats. (*Indian Forester*, Vol. LVIII, 1932, pp. 587-588.)

Chatterjee, S. N. . . Identification of teak defoliators in the field. (*Indian Forester*, Vol. LVIII, 1932, pp. 689-691.)

Chatterjee, S. N. . . *Python molurus*. (*Indian Forester*, Vol. LVIII, 1932, pp. 327-328.)

Dover, C. . . . A social spider as a pest of mango trees. (*Indian Forester*, Vol. LVIII, 1932, pp. 615-616.)

Gardner, J. C. M. . . The larva of *Calapiestus indicus* Fairm. (*Coleoptera*: Tenebrionidae). (*Proceedings of the Entomological Society of Washington*, Vol. 34, 1932, No. 8, pp. 142-145.)

Gardner, J. C. M. . . The early stages of two Indian weevils (Col. Curculionidae). (*Stylopes*, Vol. 2, 1933, pp. 81-85.)

Mathur, R. N . . The leaf curl of cotton in garden *Zinnias* in North India. (*Ind. Journ. Agric. Sci.* III, pt. I, Feb. 1933, pp. 89-96, Pl. IX & X.)

Mathur, R. N. . . On the bionomics of *Odontomyia cyanea* Brunetti. (*Ind. Journ. Agric. Sci.* III, April 1933, Pl. XXV and XXVI.)

Economic.

Chowdhury, K. A. . . The liability of Indian woods to *Lyctus* attack. (*Indian Forester*, March 1933.)

Kapur, S. N. . . . Report on the air seasoning experiments on softwood railway sleepers in the Punjab. (*Railway Board Quarterly Technical Bulletin* III—20—of April 1933.)

Popham, F. J. . . Durability tests on untreated Indian timbers. (*Indian Forester*, January 1932.)

Seaman, L. N. . . Safe working stresses for Indian timbers. (*Indian Forester*, January 1932.)

Seaman, L. N. . . Distinguishing *in* and *kanyin* timbers. (*Indian Forester*, July 1932.)

Popham, F. J., and Kamesam, S. A new wood preservative, the Falkamesam process. (*Indian Forester*, April 1932.)

Seaman, L. N. . . . Will something else do? (*Indian Forester*, December 1932.)

Chemistry.

Krishna, S., and Ghose, T. P. Seeds of *Valeria indica* as a source of vegetable tallow. (*Indian Forester*, February 1932.)

Krishna, S., and Ghose, T. P. Actinodaphnine—An alkaloid from *Actinodaphne hookeri*, Meissn. (*Journ. Ind. Chem. Soc.* Vol. IX, 429.)

Ghose, T. P., and Krishna, S. Vasicine. (*Journ. Chem. Soc.* 1932, p. 2740.)

Pantambekar, S. V., and Krishna, S. Storage of *Strychnos nux-vomica* seeds. (*Quarterly Journ. of Pharmacy and Pharmacology*, Vol. V, No. 4, 1932, p. 633.)

Ghose, T. P. . . . Preliminary chemical examination of *Dodonaea viscosa*, Linn. (*Indian Forester*, 1933, p. 78.)

Krishna, S., and Varma, B. S. Indian *Artemisias*. (*Quarterly Journ. of Pharmacy and Pharmacology*, Vol. VI, No. 1, 1933.)

APPENDIX II.

PUBLICATIONS OF THE FOREST RESEARCH INSTITUTE, DEHRA DUN, AVAILABLE FOR SALE.

	Price (exclusive of packing, postage, etc.). Rs. A. P.
I.—BULLETINS (OLD SERIES).	
4. *Ficus elastica*: its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0 12 0
6. Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0 2 0
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9. Tables showing the Progress in Working-Plans in the Provinces outside the Madras and Bombay Presidencies up to 31st December, 1908, by the same author	0 10 0
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35.	Note on Babul (*Acacia arabica*, Willd.), by J. D. Maitland-Kirwan	0 5 0
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*41.	Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion	0 8 0
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APPENDIX III.

Statement showing Officers in Charge of Branches and Sections during the year 1932-33.

Branch.	Officer-in-Charge.	Section.	Officer-in-Charge.	From	To
Silviculture .	Mr. H. G. Champion, Silviculturist.	....	....	1-4-1932	31-3-1933
		Experimental .	Mr. P. N. Deogun	1-4-1932	31-3-1933
		Statistical .	Mr. I. D. Mahendru	1-4-1932	31-3-1933
Botany . .	Mr. R. N. Parker, Forest Botanist.	....	....	1-4-1932	16-10-1932
	Mr. C. E. Parkinson, Forest Botanist.	....	....	17-10-1932	31-3-1933
		Mycology .	Dr. K. D. Bagchee	1-4-1932	31-3-1933
Economic .	Capt. H. Trotter, Forest Economist.	....	....	1-4-1932	31-3-1933
		Minor Forest Products.	Mr. F. D. Ardagh	1-4-1932	30-4-1932
			(Capt. H. Trotter)	1-5-1932	31-3-1933
		Timber Testing	Mr. L. N. Seaman	1-4-1932	27-3-1933
			(Mr. V. D. Limaye)	28-3-1933	31-3-1933
		Wood Preservation.	Mr. S. Kamesam	1-4-1932	31-3-1933
		Seasoning .	Dr. S. N. Kapur .	1-4-1932	28-2-1933
			(Mr. A. Rehman).	1-3-1933	31-3-1933
		Paper Pulp . .	Mr. M. P. Bhargava.	1-4-1932	31-3-1933
		Wood Technology.	Mr. K. A. Chowdhury.	1-4-1932	23-5-1932
			(Capt. H. Trotter)	24-5-1932	19-6-1932
			Mr. K. A. Chowdhury.	20-6-1932	31-3-1933
		Wood Workshop.	Mr. W. Nagle .	1-4-1932	31-3-1933
Entomology.	Mr. J. C. M. Gardner, Offg. Forest Entomologist.	....	....	1-4-1932	16-10-1932
	Dr. C. F. C. Beeson, Forest Entomologist.	....	....	17-10-1932	31-3-1933
		Systematic Entomology.	Mr. J. C. M. Gardner.	1-4-1932	31-3-1933
Chemistry .	Dr. S. Krishna, Biochemist.	....	....	1-4-1932	31-3-1933

APPENDIX IV.

Annual Form No. 24.

Forest Research Institute.

Summary of Revenue and Expenditure of the Branches during 1932-33.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	Total.
1	2	3	4		6	7	8
Revenue.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
V.—Miscellaneous—							
(*b*) Other sources . .	5,399	659	167	105	2,025	28	9,283
(*d*) Sale of timber and furniture from Seasoning and Wood Workshop Depôt.	..	..	..	..	256	..	256
Total Revenue .	5,399	659	167	105	3,181	28	9,539
Expenditure.							
A.—Conservancy, Maintenance and Regeneration—							
C.—Live stock, stores, tools and plant—							
C. 1.—Purchase of stores, tools and plant.	419	1,154	470	416	2,034	165	4,658
C. 2.—Communications and Buildings, New Work—							
(*a*) Roads and bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other Works . .	..	..	..	..	..	..	..
C. 3.—Communications and Buildings, Repairs and Maintenance—							
(*a*) Roads and Bridges .	..	..	..	..	..	..	..
(*b*) Buildings . . .	..	..	..	..	..	..	..
(*c*) Other charges . .	675	..	..	..	..	..	675
C. 4.—Miscellaneous—							
(1) Temporary Establishment on daily labour.	9,056	1,389	2,959	1,895	3,011	367	19,278
(2) Purchase of Timber for seasoning and preserving (including freight and carting charges).	..	..	..	..	6,827	..	6,827
(3) Purchase of coal, raw materials, chemicals and apparatus.	..	..	..	377	9,035	1,804	11,336
(4) Other charges . .	1,120	2,787	688	911	16,174	486	22,170
Total A.—Conservancy, Maintenance and Regeneration.	11,280	5,331	4,117	3,659	37,731	2,882	65,000

APPENDIX IV—*contd.*

ANNUAL FORM NO. 24—*contd.*

FOREST RESEARCH INSTITUTE—*contd.*

Summary of Revenue and Expenditure of the Branches during 1932-33—contd.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*contd.*							
B.—Establishments—							
I.—Pay of Officers—							
Non-voted—							
(*a*) Conservators . .	..	..	15,074	..	..	..	15,074
(*b*) Superior officers .	11,606	13,687	..	18,618	17,412	..	60,783
Voted—							
Superior officers . .	86	13,200	19,000	16,262	1,01,248	19,040	1,70,531
II.—Pay of Establishment—							
(*a*) Subordinate forest and depôt establishments.	..	3,028	1,975	6,577	3,033	1,572	15,885
(*b*) Office establishments .	23,106	17,300	7,005	15,800	90,754	4,022	1,58,707
III.—Allowances—							
Cost of passage (Central)—							
Non-voted	..	..	..	..	..	..	..
(*b*) House-rent and other allowances—							
Non-voted . .	..	..	..	..	..	..	..
Voted . . .	480	..	..	..	..	..	480
Travelling allowances—							
(*c*) Conservators, Non-voted	..	..	350	..	..	..	350
(*d*) Superior officers—							
Non-voted . .	..	375	..	1,200	282	..	3,006
Voted . .	..	481	1,981	2,428	590	220	5,100
(*e*) Subordinate forest and depôt establishments	..	..	13	240	..	..	253
(*f*) Office establishments .	1[illegible]	921	231	986	—172	..	1,718
Cost of passage to America of officers for training, etc.	..	..	..	..	..	..	..

APPENDIX IV—*concld.*

ANNUAL FORM NO. 24—*concld.*

FOREST RESEARCH INSTITUTE—*concld.*

Summary of Revenue and Expenditure of the Branches during 1932-33—concld.

Budget Heads.	Direction.	Silviculture Branch.	Botany Branch.	Entomology Branch.	Economic Branch.	Chemistry Branch.	TOTAL.
1	2	3	4	5	6	7	8
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
EXPENDITURE—*concld.*							
IV.—Contingencies—							
(*a*) Stationery . . .	209	8	41	..	10	..	280
(*b*) Carriage of records and tents.	10	457	251	142	..	..	860
(*c*) Rents, rates and taxes .	5,021	182	450	..	89	..	5,742
(*d*) Pay of menials . .	2,011	..	..	420	..	..	3,031
(*e*) Official postage . .	602	315	621	320	254	50	2,162
(*f*) Sundries . . .	15,021	838	1,521	2,725	1,800	2,508	24,503
(*g*) Clothing and uniform .	389	75	38	198	326	50	1,016
(*h*) Telephone . . .	1,084	270	200	246	1,558	128	3,580
V.—Cost of passage granted under Superior Civil Service Rules, 1924 (Non-voted).	412	943	380	1,200	708	..	3,013
Payment on account of medical treatment.	164	..	..	..	..	..	164
Total B.—Establishments .	61,002	54,572	49,900	66,166	2,17,766	28,408	4,78,233
GRAND TOTAL OF ALL EXPENDITURE UNDER 8.—FORESTS.	72,282	59,903	54,026	70,125	2,55,517	31,398	5,13,233
Major Head 8-A.—Share of Capital charges financed from ordinary revenue.	507			2,080			
Surplus or deficit . . .	—67,480	—50,241	—53,830	—72,450	—2,52,336	—31,322	—5,30,371

NOTE.—The figures given in this statement have been prepared in the President's office and are based on the summary of Revenue and Expenditure for March 1933 received from the Accountant General, Central Revenues. They do not include certain adjustments made in March final accounts by the Accountant General, Central Revenues, on account of leave salary, exchange accounts with other Governments and expenditure incurred through High Commissioner on miscellaneous items.

R. M. CORRIE,
for President,
Forest Research Institute and Colleges.

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